LINE PUMP SAFETY MANUAL 6

SAFETY MANUAL

A guide for the Prevention of accidents when driving, operating, cleaning, and maintaining concrete line pumps and related equipment.

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Version 6.0.1

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

SAFETY MANUAL

A GUIDE FOR THE PREVENTION OF ACCIDENTS WHEN DRIVING, OPERATING, CLEANING, AND MAINTAINING CONCRETE LINE PUMPS AND RELATED EQUIPMENT

Introduction

Safety is one of the major concerns of every person involved in the concrete pumping industry. Although much of the responsibility for everyday safety rests upon the pump operator, it is vital that everyone involved makes safety the top priority. This includes the owners, the mechanics, the ready mix drivers, the placing crew, the concrete contractors and the machine manufacturers.

Although this Safety Manual covers a great deal of information regarding the prevention of accidents while operating a concrete pump, it is unlikely that every conceivable circumstance has been covered. Regardless of how thorough a manual like this may be, there is always the unexpected. Please understand that there is no substitute for **common sense** and dedication to the idea that **you are responsible for your own safety,** and affect the safety of those around you. You have to know the rules first, but you must keep your mind on the job if knowledge of the rules is going to keep you and your co-workers alive and well. No attempt has been made in this Safety Manual to provide the highly specialized knowledge of the workings of the individual machines that is also critical for safe and proper operation. For that, you must **read and understand the operation manual for the machine(s) that you operate!**

This Safety Manual is a guide for the prevention of accidents and is to be used in conjunction with **professional training.** Additional information and materials are available through the American Concrete Pumping Association, including, specifically, an Operators Certification Program. Make the commitment to be professional - get your certification!

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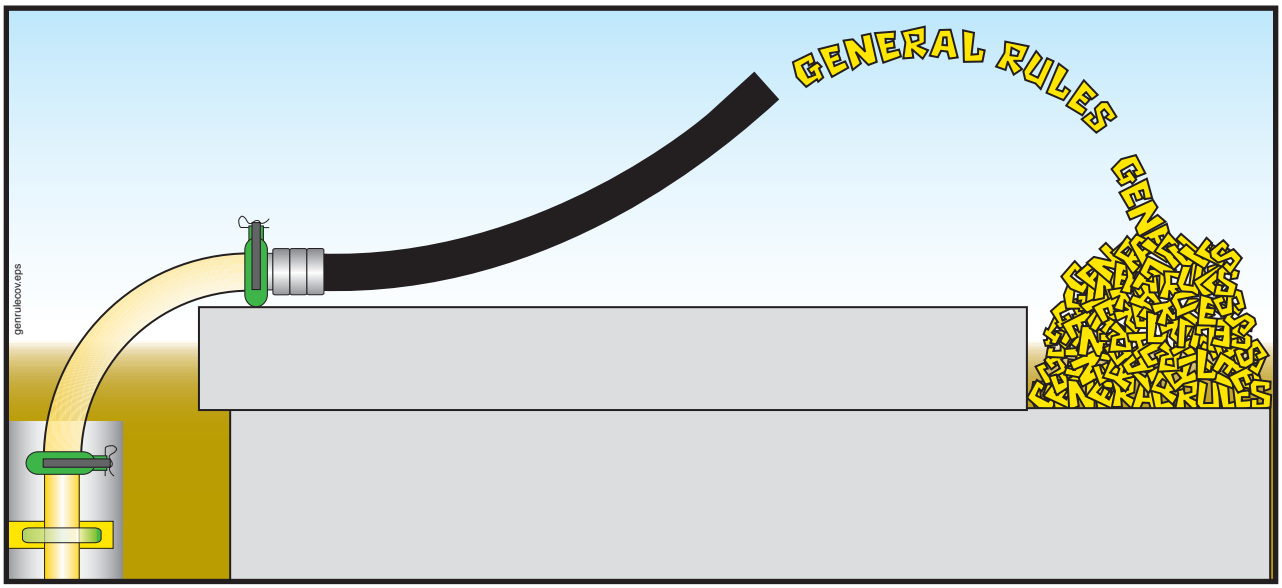

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I. Before You Leave The Yard

1. Safety Alert Symbol And Signal Word Explanation

1.1

The triangle with the exclamation point inside is used to alert you to an important safety point, and is called a *Safety Alert Symbol*. One of the following color-coded signal words will appear after the safety alert symbol:

DANGER

WARNING

CAUTION

or - without the symbol: **CAUTION** is replaced by: **NOTICE**

- If the safety alert symbol is followed by the signal word **DANGER** with white letters in a red box (DANGER), it indicates a hazardous situation which, if not avoided, **WILL** lead to **death or serious injury.**
- If the safety alert symbol is followed by the signal word **WARNING** with black letters in an orange box (WARNING), it indicates a potentially hazardous situation which, if not avoided, **COULD** result in **death or serious injury.**
- If the safety alert symbol is followed by the signal word **CAUTION** with black letters in a yellow box (CAUTION), it indicates a potentially hazardous situation which, if not avoided, **COULD** result in **minor to moderate injury.**
- The signal word **CAUTION,** used in a yellow box, but **without the safety alert symbol** (CAUTION), means the point addresses a hazard which, if not avoided, **COULD** cause **damage to equipment or property.**
- The signal word **NOTICE** (NOTICE), now replaces the signal word caution above.

2. What To Do Before You Arrive At Work

2.1

Get enough sleep to be ready for the day's work. Accidents can happen when the body is on the job, but the mind is not.

Dress in appropriate apparel and Personal Protective Equipment (P.P.E.). You should always wear these items when pumping concrete (Including *full face shield or * breathing mask where necessary as shown in Figure 1):

- hard hat
- safety glasses or goggles (*Full face shield when shotcreting)
- snug fitting clothes
- gloves
- steel toed shoes

In addition, you should wear:

- hearing protection if you stand near the pump or any other source of noise.

†† Illustration © British Concrete Pumping Association. Used by permission.

- breathing mask when mixing slurry or whenever there is cement dust in the air
- rubber gloves during cleanout
- rubber boots anytime you have to stand in concrete

Jewelry, athletic shoes, sandals, and shorts are examples of clothing that should NOT be worn when pumping.

* Breathing mask needed when cement dust (or other toxic dust) is present in the air.

* Full face shield should be used when shotcreting or any time material is rebounding.

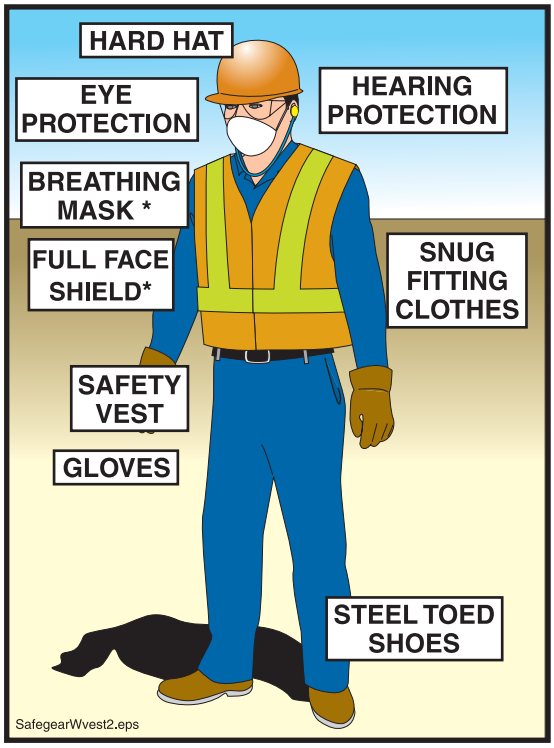


Figure 1
Personal Protective Equipment (P.P.E.)

2.2

⚠WARNING Be sure that any clothing you wear does not have strings, fringes, or other external tightening means that could be caught in moving parts (Figure 2).

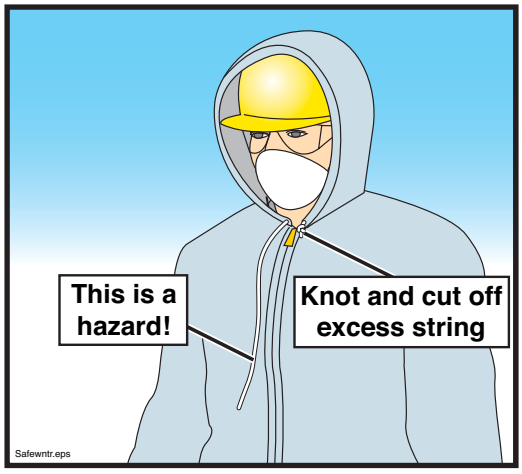


Figure 2
No strings attached

2.3 Arrive to work on time. Accidents can be caused by hurrying through procedures.

2.4 **⚠WARNING** **Never** go to work on a construction site or work on, around or near a piece of machinery when under the influence of drugs or alcohol. Beware of prescription medications or "over the counter" drugs, many of which have specific warnings about operating machinery after taking the medication (Figure 3).

Figure 3
Your co-workers depend upon you for their safety

2.5 **⚠WARNING** Don't bring your personal problems to work with you. In an office setting this may be annoying to co-workers, but on a construction site it can be deadly. The workers around you depend on you for their safety.

3. What To Check Before You Leave The Yard

3.1 **⚠WARNING** Do not operate the machine until you read and understand the unit's operation manual. Lack of understanding of proper operating procedures could result in unsafe operation. Operation manuals are issued with each new unit. If you haven't seen it, ask your supervisor. Replacements are available from the manufacturer.

3.2 **⚠WARNING** Inspect delivery pipes, concrete delivery hoses, and end hoses for wear. Never use a hose or pipe that is dented or worn out. **Know the maximum pressure that your machine can exert on the concrete, and be sure that the pipes, hoses and clamps are capable of handling the pressure.** Maximum pressure on concrete is stated in operation manuals, service manuals, and on the serial number plate of the machine. A chart showing the minimum wall thickness of pipeline versus maximum pressure is found on page 51 in the Appendix section of this Safety Manual.

3.3 **⚠WARNING** If you will need to use compressed air to clean out the system pipeline, BE SURE that you have the proper training, equipment, and attachments to do this procedure safely! Proper attachments include:

- A blow out head with properly sized air discharge regulator valve and separate water/air inlet. The two openings should be spaced apart far enough that a blowout ball could not cover both openings at once.
- A *go devil*, or a hard sponge ball. Regardless of which is used, it **must** fit into the pipeline tight enough that air cannot escape ahead of it.
- A ball or go devil catcher that will catch the go devil or ball when the line has been purged of all concrete, unless another method of controlling the outlet is used. There are two types of catchers (see paragraph 5.23 on page 17).
- A hose that is rated for the pressure of the air compressor you will use and that is able to connect with both the air compressor and the blow out head. The hose must be in good working condition and must be free of cracks, frays, tears or other damage. Do **NOT** improvise on this. **Make sure** that you have the right part (Figure 4).

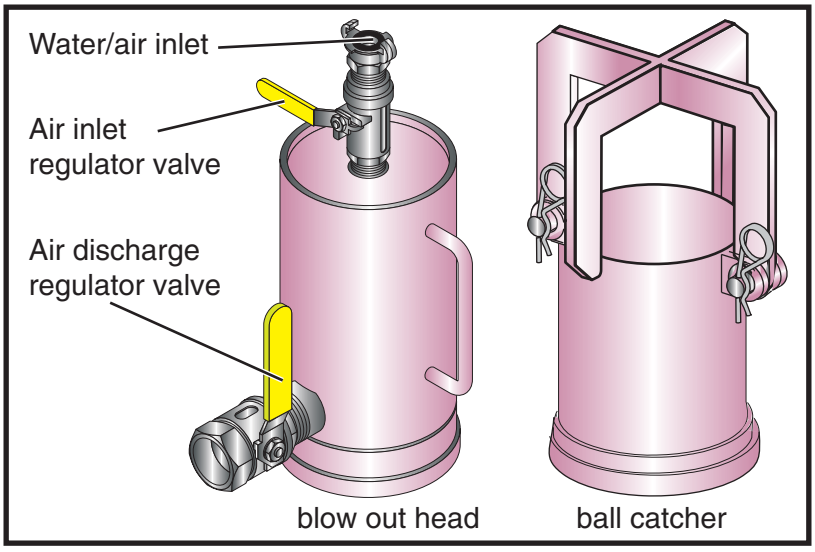


Figure 4
Compressed air accessories

3.4 **⚠WARNING** Be sure that the unit is equipped with all the pipes, clamps, gaskets and hoses, blow out adapters, ball catchers, and other accessories that you will need for the day's work. "Making do" with inappropriate equipment could cause accidents.

3.5 On trailer mounted units, check the oil and cooling system (air or water cooled systems) of the pump drive engine. Accidents could occur when lack of maintenance is causing a distraction while operating the equipment.

3.6 Be sure the battery has enough charge to start the pump drive engine. You will be rushed on the job if you have to do repair work before you can begin operation.

3.7 **⚠WARNING** The operator is responsible for checking to see that the concrete pump, and delivery system are in safe and proper working condition. If an unsafe condition exists, **work must not begin** until necessary repairs have been completed, or until the machine can be operated safely.

3.8 **⚠WARNING** The operator is responsible for checking that all safety equipment and guards are in place and in good condition. If found to be missing, incomplete, or damaged, **work must not begin** until the situation has been made safe.

3.9 **⚠WARNING** The operator is responsible for checking that all safety decals are in place and are in readable condition. If found to be missing or unreadable for any reason, steps should be taken to obtain replacements.

3.10 **⚠WARNING** Inspect the tires and brakes on the truck. Never drive a truck with bald or cracked tires, or with weak or worn brakes. If you have air brakes, be sure that the air system is free from leaks and will maintain pressure when driving. Loss of air pressure will cause the brakes to be applied while driving. If driving continues after the brakes are applied, the resulting friction could cause enough heat to start a fire.

3.11 Drain moisture from the air tanks that supply the unit's brakes (if so equipped). This is especially important if weather conditions could cause the moisture to freeze. If you lose air pressure because of frozen moisture, the brakes will apply themselves, and you will have to stop driving until the unit is repaired.

3.12 **⚠WARNING** (See Figure 5.) Mount or dismount the pump or truck using the *3 Point Rule* (i.e. keep two hands and one foot or one hand and two feet in contact with a secure surface at ALL times).

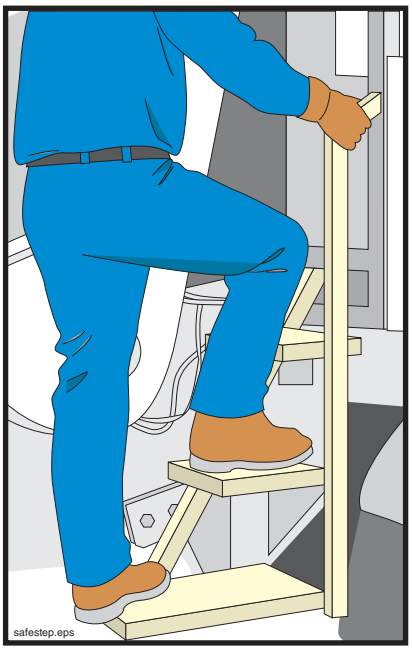


Figure 5
The 3 Point Rule

3.13 **⚠WARNING** Never mount or dismount the truck or pump while carrying objects that prevent you from using the "3 Point Rule." Move the objects separately, if needed.

3.14 **⚠WARNING** If applicable, be sure that outriggers are pinned and locked before traveling. If the locking device is damaged or worn, it should be repaired immediately and the unit **must not be driven until the outriggers can be positively locked** against accidental opening.

3.15 **⚠WARNING** Be sure there is nothing in the cab of the truck (such as empty soda cans, loose tools, etc.) that could interfere with the operation of the vehicle.

3.16 Be sure that all road-related safety devices (warning signs, flares, fire extinguisher, etc.) are present and secured for travel.

3.17 Be sure all personal protective equipment (hard hat, safety goggles, rubber gloves, etc.) are secured for travel.

3.18 **⚠WARNING** Be sure the windshield and mirrors are clean and free of frost or ice, and that the mirrors are properly adjusted.

3.19 **⚠WARNING** Verify that head lights, tail lights, turn signals, brake lights, backup warning horn, and backup lights are operational.

3.20 In some cases you may be asked to operate a machine other than the one with which you are familiar. In these cases, be sure to:

- Know the weight, height, and width of the machine.
- Have a copy of the operation manual with you.
- Ask the machine's normal operator, the dispatcher, or your supervisor questions regarding any unusual or unique operational characteristics of the machine.
- Familiarize yourself with the machine by setting it up in the yard and running the functions, and by familiarizing yourself with the operation manual. This is especially important if the new machine is significantly different than the one you normally operate. Your co-workers depend on you to know the machine.

3.21 **⚠WARNING** Be certain that all loose items on the unit are secured for travel before driving.

3.22 **⚠WARNING** Emergency stop switches should be periodically checked by activating the switch in the yard and confirming that none of the pump functions operate electrically or manually.

4. Safety Rules For Towing Trailer Mounted Concrete Pumps

4.1 **⚠WARNING** Be sure the towing vehicle is heavy enough and has enough horsepower and braking ability to tow the trailer. This is critical to maintaining control at highway speeds and to braking ability. If the trailer is heavier than the towing vehicle, braking distances will be greatly increased (Figure 6).

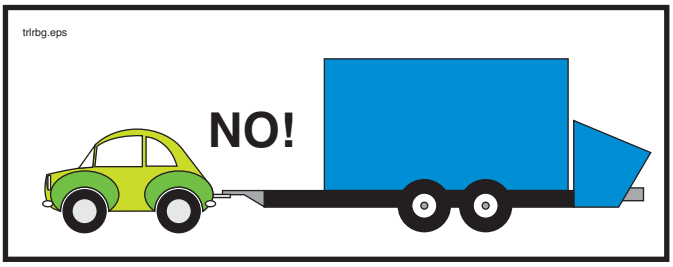


Figure 6
Do not under size the towing vehicle

4.2 **NOTICE** Never drive the unit with concrete in the hopper. The extra weight in the back of the machine will remove weight from the tongue and cause the unit to fishtail.

4.3 **⚠WARNING** Check the tires, tire pressure, and brakes on the trailer before towing. Never tow a vehicle with cracked or bald tires. A trailer tire blowout can cause loss of control in the towing vehicle.

4.4 **⚠WARNING** Be especially careful on ice or slippery roads when towing a trailer. A skid that would normally be easily correctable can be multiplied by the trailer, causing loss of control.

4.5 **⚠WARNING** Be sure that the electrical connections between the towing vehicle and the trailer are sturdy and reliable, and that the lights on the towing vehicle and trailer are working.

4.6 **⚠WARNING** Always use safety chains and break-away protection when towing a trailer.

4.7 **⚠CAUTION** Be aware of local or state regulations regarding mirrors and lights when towing a trailer.

4.8 **⚠WARNING** When towing a trailer, your stopping distance and turning radius are greatly increased. Be aware of this **at all times.**

4.9 **⚠WARNING** When towing a trailer long distances, it is important to check the hitch, wiring, and safety chains frequently.

4.10 **⚠WARNING** Be aware of your length when towing a trailer. A common cause of trailer accidents is turning too close to curbs or objects.

4.11 **⚠WARNING** Never back up a trailer without a guide.

4.12 **⚠WARNING** Frequently observe the trailer and watch for unusual swerving or indications of problems, such as a flat tire.

II. On The Job Site - Safety Rules For Job Setup

5. Setting Up A Trailer Mounted Pump and/or A Separate Pipeline

5.1 **The job setup phase sets the stage for most accidents.** Taking a few extra moments to correctly set up the job will improve your chances of having a safe, trouble free day.

5.2 **The operator is responsible for the safe operation of the machine.** Notify your employer, the job superintendent, and/or O.S.H.A. if you are being asked to set up in an unsafe manner. **You are never required to take a chance with safety.** You are the **only** person who can determine that the job circumstances under your control are safe.

5.3 **⚠WARNING** **Any power connections above 24 volts must be made by a licensed electrician.** The supply power and appropriate disconnect boxes are the responsibility of the contractor.

5.4 **⚠WARNING** **Electrical power on the job site may be taken only from a fused, grounded disconnect box with a disconnect switch that can be locked against activation.** If you will be making repairs to the concrete pump or separate placing boom, first lock out the power at the disconnect box.

5.5 **⚠WARNING** On units equipped with electric motors, **check the power cables every day.** If they are frayed or have open spots in the insulation, replace the wire. If the connectors are worn or loose, have repairs made by a licensed electrician.

5.6 **⚠WARNING** **Consider the safe approach and departure of the ready-mix trucks and adjust your setup accordingly.** Adjusting your setup position by a few degrees one way or another could mean the difference between a safe approach and an unsafe approach. Some examples of unsafe approaches are: too near an excavation or sticking out into traffic.

5.7 **⚠WARNING** **Avoid collisions!** Secure the immediate area of the machine from public traffic in accordance with all applicable regulations (warning lights, safety cones, barricades with flashers, etc.).

5.8 **⚠WARNING** Pipelines, end hoses, couplings, and all other **material delivery components must be able to withstand the maximum concrete pressure of the pump. Be sure** of it! Read and understand the minimum wall thickness chart found in the *Appendix* of this manual. If you don't understand the chart, contact the pipe manufacturer for assistance.

5.9 **⚠WARNING** Do not use a piece of pipeline, end hose, coupling, or any other material delivery component that is not in good condition. **Replace, do not repair damaged pipes and hoses.** Concrete pipeline system is subject to wear, and the rate of wear is affected by pumping pressure, concrete composition, pipeline material, and other factors. Read and understand the minimum wall thickness chart in the *Appendix* of this manual. **Bursting pipes and concrete escaping under pressure is a serious safety hazard (Figure 7)!**

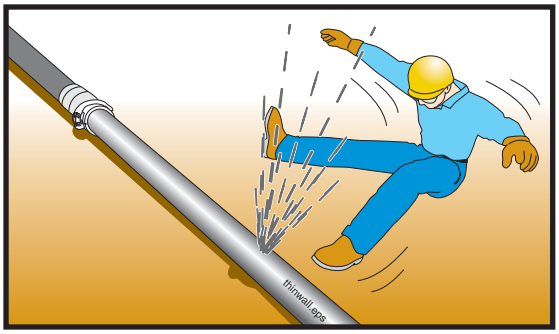


Figure 7
Delivery system components must be able to withstand maximum pump pressure

5.10 When laying out a pipeline, it is preferable to use an elbow instead of a hose to make direction changes. Elbows have less resistance to flow than hoses, and will therefore reduce the overall pressure required to push the concrete.

5.11 Always use the largest diameter pipeline that is practical, and use steel pipe instead of rubber hose. This will keep the pressure required to push the concrete to a minimum.

5.12 Support the delivery pipeline. Either an "S" transition pipe should be used to bring the pipe to ground level, or **each** section of the pipeline should be supported at the pump outlet level.

5.13 **⚠WARNING** The sections of pipe nearest the pump are subjected to the highest pressure and the greatest wear. Because of this increase of pressure near the pump, you should install only thick walled pipe, in "like new" condition there. Read and understand the minimum wall thickness chart in the *Appendix* of this manual.

5.14 **⚠WARNING** **The maximum concrete pressure of the pump must be the only factor used to determine what thickness of pipe and what type of ends are needed.** In the case of a rock jam or any other type of blockage, **the maximum pressure of the pump will be exerted.**

5.15 Grooved (Victaulic) ends are **not recommended** for concrete pumping. Read and understand the comparison between heavy duty raised, metric, and grooved ends in the *Appendix* of this manual.

5.16 **⚠WARNING** If the pipeline remains on the job (as is the case when pumping a high rise building), **the operator is responsible for checking the pipeline for dents, cracks, wear, and continuity each day before the pour begins.**

5.17 **⚠WARNING** In vertical runs, the weight of the vertical sections of pipe must be supported by a thrust block (often called a *deadman,* Figure 8) or other load-bearing device. **Each section of pipeline in a vertical run must be secured from lateral and horizontal movement.**

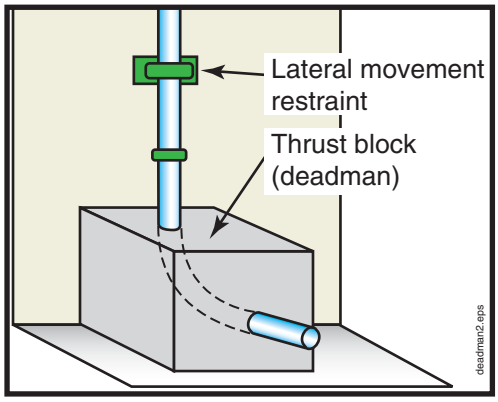


Figure 8
A thrust block (deadman)

5.18 **⚠WARNING** If you will be unable to see the point of placement, establish a system of communications with the workmen who will be there. Arrange for radio communications, a system of visual or auditory signals (lights or bells), or a spotter (Figure 9). If a spotter is used, **agree on hand signals before beginning the pour!**

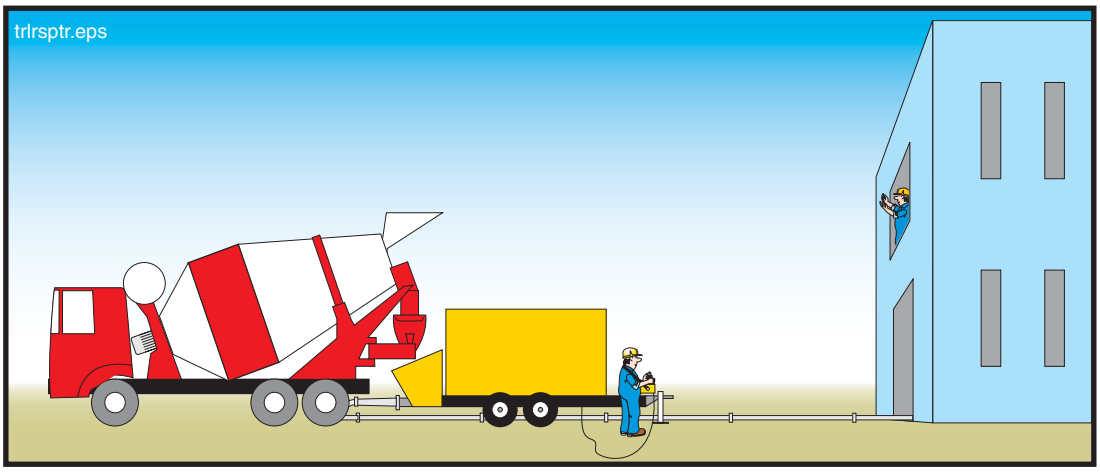


Figure 9
Arrange communications before starting

5.19 **⚠WARNING** Never leave the machine unattended when it is running or ready to run. If you must leave the area, you must leave someone to monitor the unit. This is especially critical if there are children in the vicinity.

5.20 **⚠WARNING** Watch for children! It is possible for children to access the machine, but it is not safe for them to do so.

5.21 **⚠WARNING** If spectators will be near the job, cordon off an area where they will be safe.

5.22 **⚠WARNING** If you will be cleaning the pipeline with compressed air at the completion of the job, **be sure that you have all the necessary accessories to do the job safely.** If you don't have all of them, make arrangements to get them before you begin to pump. **Do not improvise on this. Make sure** that you have the right parts. The minimum accessories include:

- A blow out head with properly sized air discharge regulator valve, and separate water/air inlet. The two openings must be spaced apart far enough that a blowout ball could not cover both openings at once.
- A *go devil*, or a hard sponge ball. Regardless of which is used, it **must** fit into the pipeline tight enough that air cannot escape ahead of it.
- A ball or go devil catcher that will catch the go devil or ball, or some other method of controlling the discharge while the line is being purged of material. There are two types of catchers (see paragraph 5.23).
- A hose that is rated for the pressure of the air compressor you will use and that is able to connect with both the air compressor and the blow out head. The hose must be in good working condition and must be free of cracks, frays, tears or other damage.
- If you will be cleaning the pipeline with compressed air at the completion of the job, be sure an adequate air compressor is available before starting the job.
- If you will be cleaning a vertical pipeline with compressed air at the completion of the job, you **must have a shutoff valve or switching valve installed at the bottom of the vertical run!**

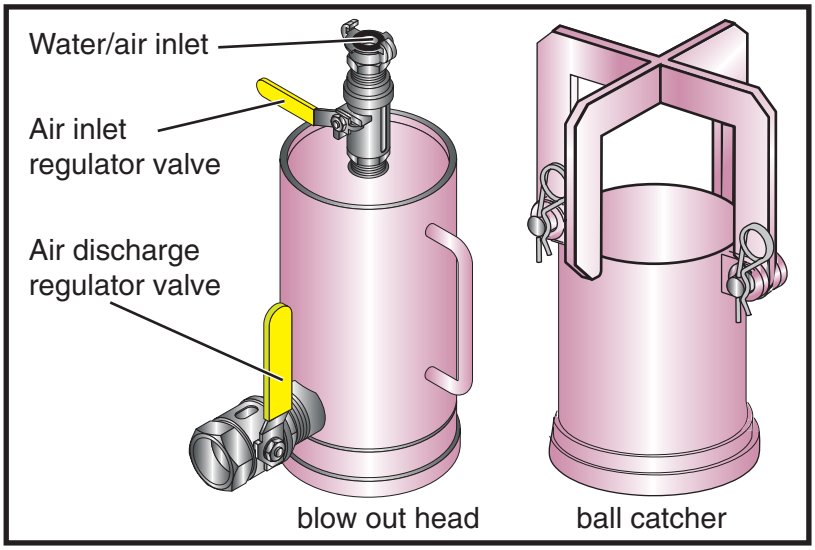


Figure 10
Ball catcher and blow out head

5.23 **⚠WARNING** There are two types of ball catchers. Know which type of catcher you are using. You may need to adjust your clean out procedure according to which type you have. The two types are as follows:

1. Catchers that stop the ball or go devil before air can escape, and
2. Catchers that allow the air out of the pipeline after the ball or go devil has reached the end.

Each type of catcher has advantages and disadvantages (Figure 11).

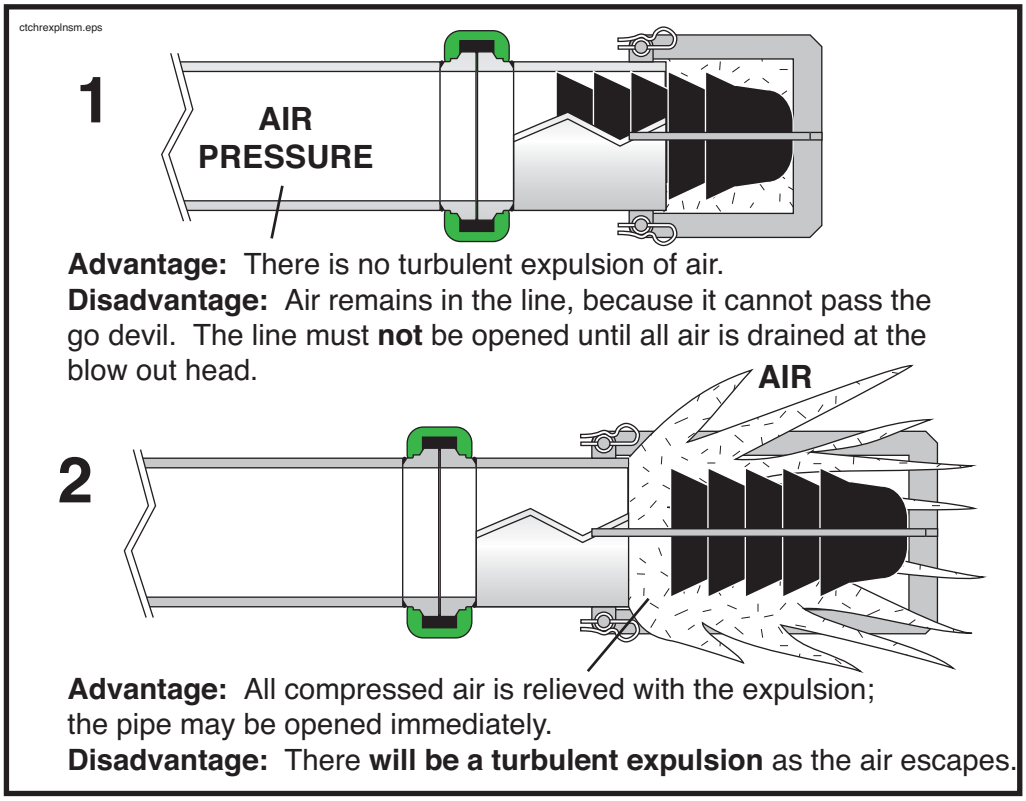

ctchrexplnsm.eps
1
AIR
PRESSURE
Advantage: There is no turbulent expulsion of air.
Disadvantage: Air remains in the line, because it cannot pass the go devil. The line must not be opened until all air is drained at the blow out head.
AIR
2
Advantage: All compressed air is relieved with the expulsion; the pipe may be opened immediately.
Disadvantage: There will be a turbulent expulsion as the air escapes.

Figure 11
Types of catchers

With catcher type 1, the go devil stops, but air is still trapped behind it. The advantage is prevention of the sometimes violent expulsion of air at the end of the pipe. The disadvantage is that the air must be drained from the blow out head before the pipe line is safe to open. The pipeline must be controlled; allow no one to open it until all compressed air is relieved.

Catcher type 2 is long enough that the compressed air escapes behind the go devil. **Note!** This would happen with either catcher when used with a ball instead of a go devil. The advantage of this is that once you hear the turbulent expulsion, there is no pressurized air remaining in the line, and the line may be opened immediately. The disadvantage is the expulsion itself. In this case, the end of the line must be controlled because flying concrete and aggregate pose a hazard.

Both catchers can be safely used if care is given to the hazards involved.

III. Concrete Pump Operation

6. Safety Rules For Pump Operators

6.1 **⚠WARNING** Only qualified operators are allowed to operate the pump. A "Qualified Operator" is defined as someone who:

- has reached the age of 18 years (21 for interstate travel),
- is physically and mentally capable,
- has been trained in the operation and maintenance of the pump and the placing boom (if applicable),
- has demonstrated his/her capabilities to the employer in respect to the operation and maintenance of the pump and placing boom (if applicable), and
- can be expected to perform these duties, as assigned, in a reliable manner.

6.2 **⚠WARNING** Because the operator is responsible for the safe operation of the machine, it is crucial that he/she understands the proper operation of the machine and the safety rules that apply to the job at hand, so the course of action taken in unforeseen circumstances will be a safe one. Only thorough training and supervised job experience can supply the necessary understanding.

6.3 **⚠WARNING** When operating the machine, **wear Personal Protective Equipment.** (Including *full face shield or * breathing mask where necessary as shown in Figure 12.)

* Needed when exposed to airborne cement particles (or any other toxic dust).

* Full face shield should be used when shotcreting or any time material is rebounding.

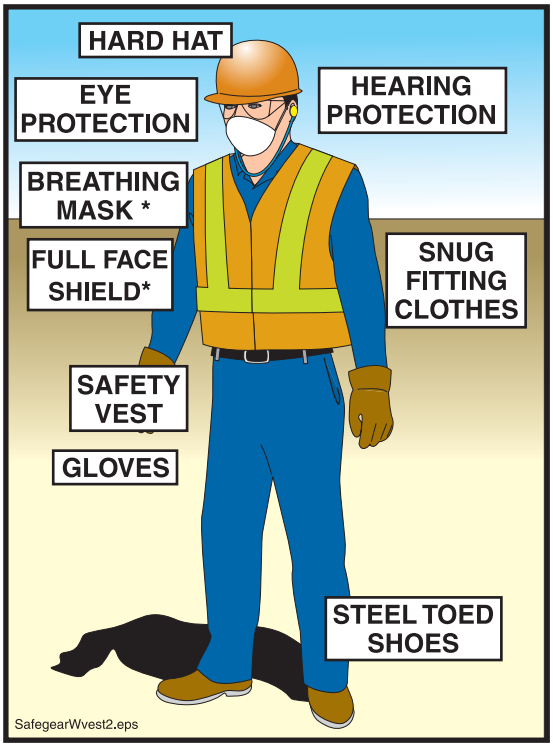


Figure 12
Wear Personal Protective Equipment (P.P.E.)

6.4 **⚠WARNING** All guards, covers, and service flaps must be secured in place during operation.

6.5 **⚠WARNING** **Electrocution hazard!** If you are operating and lightning moves into the area, seek shelter until the lightning is gone.

6.6 **⚠WARNING** **Crushing hazard! Never, ever** position yourself between a ready mix truck and the pump! Stand off to the side, so the ready mix driver can see you at all times (Figure 13).

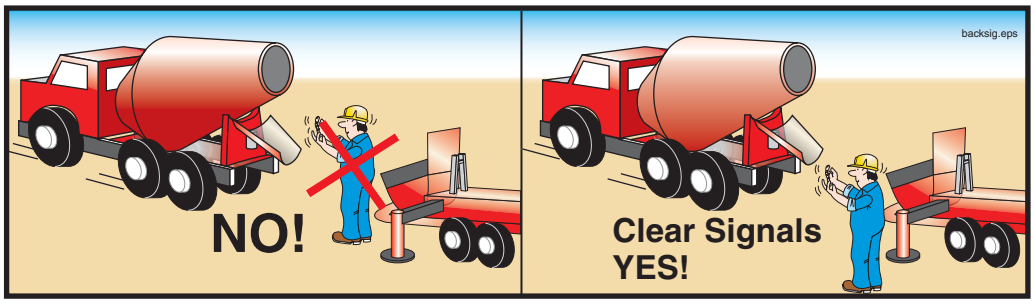


Figure 13
Never stand between the ready mix truck and the pump
Use clear and concise hand signals

6.7 **⚠WARNING** When backing in ready mix trucks, use clear and concise hand signals (Figure 13).

6.8 **⚠WARNING** If the job requires that you work above ground to operate your machine, an approved fall protection plan must be implemented.

6.9 **⚠CAUTION** **Loss of hearing!** While standing near a working concrete pump, sound pressure levels may exceed O.S.H.A. standards for constant exposure (Figure 14).

PERMISSIBLE NOISE EXPOSURES*
*Under part 1910.95 "Occupational Noise Exposure," (Dept. of Labor) of the Code of Federal Regulations, Chap. XVII of Title 29 (39 F.R. 7006).

DURATION per DAY in HOURS	Sound level in dB (A) Slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or LESS	115

WEAR HEARING PROTECTION! ††

Figure 14
Noise level and exposure time limits

6.10

WARNING **Do not let the concrete level in the hopper become low!** If air is sucked into the material cylinders, the pump will compress the air. Compressed air always poses a hazard as it is expelled from the hopper or the delivery pipeline (Figure 15). If air is taken into the material cylinders, take the following steps to minimize the hazard:

1. Stop the pump immediately. Hit the emergency stop button if that is the quickest way to stop the pump. There will be an expulsion of compressed air the next time the concrete valve shifts, which can be safely absorbed by filling the hopper with concrete.
2. If possible, fill the hopper with concrete to just below the grate, then pump slowly in reverse for several strokes. This will not remove all the air, but it should minimize the amount left in the pipeline.
3. Persons standing at the discharge end or near the delivery line must be warned to move away until all of the air has been purged. Personnel should move a prudent and reasonable distance beyond the end-hose movement area or the point of discharge, and personal protective equipment (PPE) should be worn (Figure 15).
4. When the pump is restarted, pump forward slowly until **all** air is removed from the pipeline. Don't assume that the first little air bubble is the end of the compressed air.
5. Do not allow anyone near the discharge until concrete runs steadily from the end and there is no movement of the delivery system.

If workers are positioned in high or precarious places, warn them to expect a loud sound as the air escapes the pipeline. (Warn them even if they are well away from the discharge.) That way, we can prevent the worker from falling as a result of being startled by the noise.

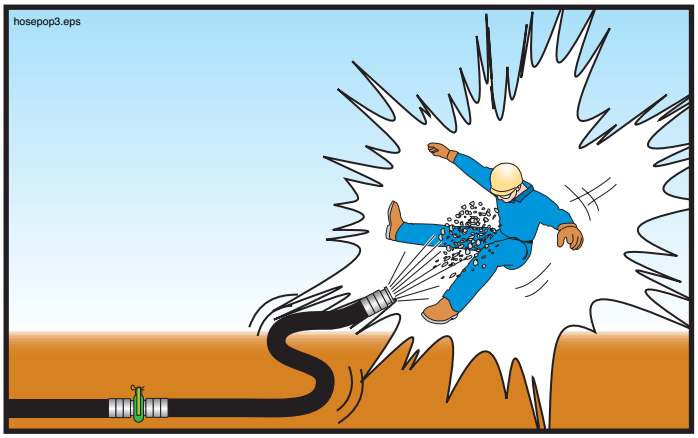


Figure 15
Remove everyone from the discharge area whenever air is in the line

6.11 **⚠WARNING** Air can be introduced into the delivery system in several ways.

For example:

- when initially priming the delivery system,
- when restarting after moving,
- when restarting after adding or removing delivery system
- when attempting to remove a blockage by "rocking" the concrete,
- when pumping is stopped and the pipeline is at a downward angle.

6.12 **⚠WARNING** When initially priming the delivery system, when restarting after moving, when restarting after adding or removing hoses, when attempting to remove a blockage by "rocking" the concrete, or whenever air has been introduced into the line, warn everyone to stay away from the discharge until material runs steadily. Personnel should move a prudent and reasonable distance beyond the end-hose movement area or the point of discharge, and personal protective equipment (PPE) should be worn (Figure 15).

6.13 **⚠WARNING** **Blockages in the pump or delivery pipeline can create an unsafe condition.** Blockages are caused by many different factors, as outlined below.

CAUSES OF BLOCKAGES

- **Faulty concrete mix design.** The concrete that is being supplied may not be a pumpable mix, for example there may be too much sand or too little cement. There may be bleeding or segregation. Some admixtures adversely affect pumpability (e.g., too much air entrainment). If the mix is not pumpable, no amount of operator expertise will make it so.
- **The line size may be inadequate.** The line size should always be at least 4 times larger than the largest aggregate being pumped, or blockages could occur.
- **Worn concrete valve parts.** Worn parts allow the finest material and water to escape back into the hopper when pressure is applied.
- **Pipeline and joint deficiencies.** This would include dirty pipes (pipes that have not been cleaned properly), worn and leaking pipe joints that allow loss of concrete fines and water, pipes that haven't been properly primed before starting, and too many sections of rubber hose, which increases friction. These are all causes of blockages that can be controlled by the operator.
- **Pump inadequate for the application.** The pump selected for the job may not have enough pressure or horsepower available for the required duty.
- **Concrete setting up in the pipeline.** This may be caused by delays on site (e.g., repairing a broken form), or by attempting to pump "old" concrete (concrete that was batched hours before pumping and is being kept alive only by adding water and constant agitation). Weather conditions can also affect how quickly the concrete becomes hard. Companies should establish procedures for these situations. A good rule of thumb is: **If in doubt...wash out.**
- **Foreign matter in the concrete.** Pieces of old concrete that break away from mixer fins, unmixed clumps of cement, mixer fins, hammers, and furry mammals are examples of foreign matter that have caused blockages.

- **An inexperienced operator can cause blockages by setting up the job improperly.** For example, if the placing crew is forced to add hose or pipe to reach a far point after the pour is already in progress, there is a great chance of creating a blockage due to the dry conditions inside the pipe or hose. It is for this reason that the job should be set up so pipe or hose need only be removed (never added) as the day progresses. If dry pipe or hose must be added, it must be lubricated just like the rest of the pipe was lubricated when you first started.
- **An inexperienced or improperly trained placing crew can cause blockages by kinking the end hose.** This type of blockage can lead to serious accidents because the hose may un-kink by the force of the pump.
- **The concrete becomes segregated in the hopper.**
  a. If the concrete is too wet, the cement and fine material get washed from the stone and course sand. This mix will not pump. It is for this reason that you should cover the hopper as you wait out a passing storm, never allow a truck mixer to wash out in your hopper, and never add water to the mix.
  b. If concrete is over vibrated, it will separate. Turn off the hopper vibrator when not actively pumping.

6.14 **⚠WARNING** Never try to remove a pipeline blockage by applying high pressure to it, because that will cause the blockage to become a plug. If you have a blockage, immediately stop the pump. Stroke the pump several times in reverse. Slowly stroke the pump in forward, and try to dislodge the blockage. If you are moving the blockage, continue to do so slowly and gently. While attempting to clear the blockage, remove all personnel from the discharge area, as air may be introduced into the placing line during this process. If you are unable to move the blockage after a couple of attempts, stop the pump. Continuing to apply high pressure could create a hazardous condition.

6.15 **⚠WARNING** If the pump or associated equipment develops a problem that creates an unsafe condition, you must stop pumping immediately! Do not restart until the unsafe condition has been remedied.

6.16 **⚠WARNING** The following points must be observed when locating a blockage.

- Pump in **reverse** for **at least two strokes,** then stop the pump. **Do not allow anyone to open the pipeline** until this is done (Figure 16).
- Wear personal protective equipment (PPE) when opening a blocked pipeline.
- Clear the area of nonessential personnel before opening the line.
- Plugs will be found in (in the order of likelihood) reducers, hoses, elbows, and pipe.

- If you are tapping the pipe to find the plug, the sound will be a dull thud (tik-tik) rather than a ringing sound (tong-tong) at the spot of the plug, because the jammed material will keep the pipeline from vibrating. (This method won't find a plug in a hose.)

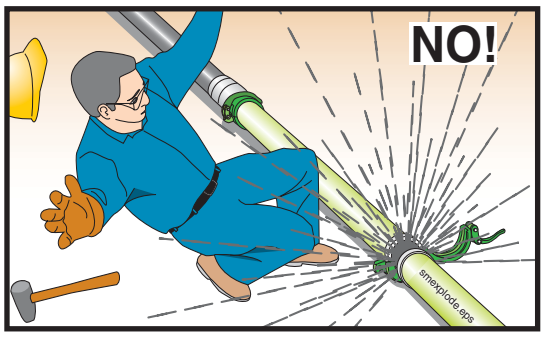


Figure 16
Never open a pressurized pipeline

6.17 **⚠WARNING** It is possible that some pressure will remain in the pipeline after reversing the pump. Use a shovel or pry bar to open the clamps on a blocked pipeline. Wear face protection, and turn away from the pipeline when opening the clamp.

6.18 **⚠WARNING** It would be better to let the pipe be ruined by setting concrete than to risk injury by ignoring safe procedures. Always use safe practices when cleaning pipe. Remember, pipeline is replaceable, you are not.

6.19 **⚠WARNING** **Do not kink hoses.** Kinking will cause the pump to create maximum concrete pressure. **The pump may unkink the hose with force!** (See Figure 17.)

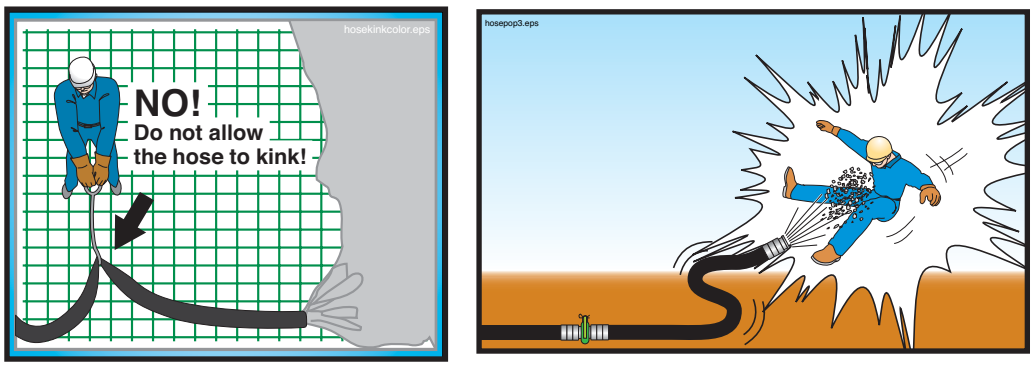


Figure 17
Kinking the hose creates a hazard

6.20 **⚠WARNING** Never use compressed air to clear a blockage! It is unsafe and unnecessary. The pump can develop much more pressure than an air compressor. If the pump pressure can't move it, air pressure won't either.

6.21 **⚠WARNING** Never stand on, sit on, or straddle a pipeline while it's in use, or whenever it is pressurized. Pipeline wears out with each stroke of the pump. If the pipe bursts, you want to be to the side of it, not on top of it (Figure 18).

Figure 18
Never straddle or sit on a pressurized pipeline

6.22 **⚠WARNING** Crushing/amputation hazard. Do not remove the water box covers or grates when the machine is stroking (Figure 19). If you must remove the water box cover (to add water, for example), and there is not a bolt-down grate over the water box, then stop the pump, take the transmission out of gear, so the pump cannot be restarted until you are finished and the covers are back in place. If a bolt-down grate is installed, you may simply stop the pump from stroking before removing the water box covers. Replace the covers before restarting the pump.

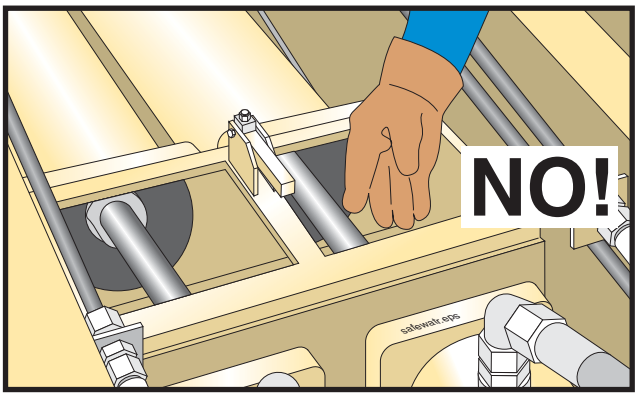


Figure 19
Keep your body out of the waterbox

6.23 **⚠WARNING** **Never leave the pump unattended!** Before you leave a laborer, ready mix driver, or any other worker alone with the pump for any reason, make sure the worker who you leave with the pump knows:

- the safety rules for a person stationed at the pump (the rules are listed in this *Safety Manual*, beginning on page 39),
- how to stop the pump,

- the location of the emergency stop switches,
- how to signal you.

6.24 **⚠WARNING** To prevent any unintentional movements of the machine, **all** control devices on the operator's panel and the remote control box must be switched off before changing from remote control to local control, or vice-versa. Whenever you are connecting or disconnecting the remote cable, push in the emergency stop button.

6.25 **⚠WARNING** Crushing/amputation hazard. Never put your hands, feet, or any other body part into the water box, concrete valve, or hopper when the hydraulic system is operational or ready to operate! (See Figure 20.)

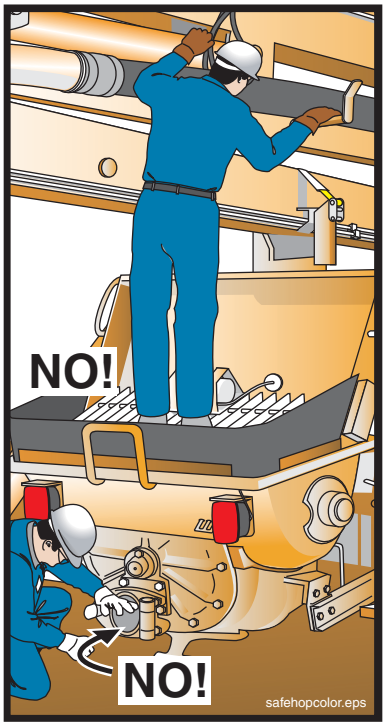


Figure 20
Don't put your body in the machine

6.26 **⚠WARNING** Do not work on the hopper, water box, concrete valve, or the hydraulic system unless the drive engine is turned off and the accumulator pressure (if so equipped) has been released! On units with internal combustion engines, the key must be removed. If there is more than one key, you should tag the ignition. On units driven by electric motors, the main disconnect must be locked out according to applicable standards.

6.27 **⚠WARNING** Never operate the pump "blind." If you can't see the point of placement, you must establish a system of communications with the workmen who can see the point of placement. Arrange for radio communications, a system of visual or auditory signals (lights or bells), or a spotter. If a spotter is used, **agree on hand signals before beginning the pour!** (Use of the ACPA standardized hand signals is highly recommended.)

7. Safety Rules For Shotcreting

7.1 Keep the pump clean. A clean machine runs more safely and efficiently. To enhance the cleaning of your pump it will help to spray some type of bond breaker on the entire unit before each use (form oil or equivalent).

7.2 **⚠WARNING** The nozzle man and those working near him should always protect themselves by wearing appropriate safety gear, including a full face shield to prevent rebounding concrete from injuring their face and eyes (Figure 21).

Figure 21
Wear a full face shield for rebound protection

7.3 **⚠WARNING** Always direct the reducers away from the operator and the concrete mixer driver. The line pressures are always very high during the shotcrete process (Figure 22).

Figure 22
Always point reducers away from the operator and driver

7.4 If possible, the nozzle man and the pump operator should use radios to communicate with each other to facilitate a fast shut down in the event of a line plug.

7.5 **⚠WARNING** If setting up on a city street or some other obstacle prevents you from directing the reducers away from your work station, it can be helpful to use rubber matting and bungee cords to cover the reducers and act as a protective cover to protect you and the mixer driver in the event of a line rupture (Figure 23).

Figure 23
Cover reducers and use containment boxes for cleanout

7.6 **⚠WARNING** Crushing/amputation hazard! Always keep the hopper grate in place (Figure 24). Never put your hands, feet, or any other body part into the concrete valve, hopper, or water box when the hydraulic system is operational or ready to operate! Never stand on the hopper grate!

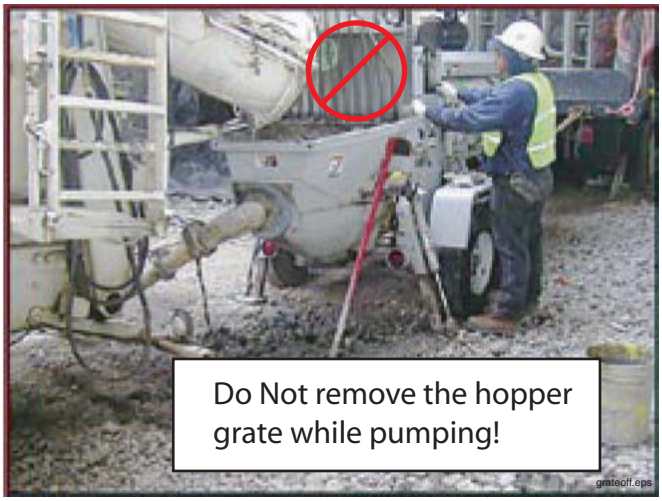


Figure 24
Never remove the hopper grate while the pump is operating

7.7 **⚠CAUTION** Overspray always presents a serious problem during the shotcrete process. Always protect personnel and equipment in the area by providing overspray protection. Even when you are shooting on the inside. The most commonly used protection is plastic sheeting. It is easy to work with and can be nailed or fastened to almost any surface. Canvas tarps can be used in the same manner, but need to be cleaned frequently. Masonite and plywood also work well in some instances. It can help to over-form the area where shotcrete is to be applied. For example, if a wall is to be six feet high, you can form it to eight feet creating a two foot area of protection. The same would apply to the end of a wall.

7.8 **⚠WARNING** Always check all forms and rebar for stability, both backward and forward, before shotcrete is placed. The rebar cage needs to be tied to something, usually the back form. When the shotcrete wall is being built up, the placed shotcrete wants to sag forward, bringing the rebar with it. If the rebar moves it is very likely that the form moved as well.

IV. Cleaning The Pump And System

8. Safety Rules For Cleaning The Concrete Valve & Hopper

8.1 **⚠WARNING** Wear protective clothing and equipment when cleaning the concrete pump because the lime in concrete can burn your skin. Protect against concrete burns and concrete poisoning by wearing rubber boots and gloves during cleanout or any other time that you will be **in** contact with the concrete.

8.2 **⚠WARNING** Crushing and amputation hazard! **Never put your hands or any other body part into the concrete valve.** Instead, use water jets and the supplied rake (Figure 25).

8.3 **⚠WARNING** **Never put your hands or any other body part into the machine when the hydraulic system is operational.** If you must remove the grate to chip at hardened concrete, you must first disable the system by taking the transmission out of gear and locking the cab door, or stopping the engine, relieving pressure in the accumulator circuit (if so equipped) and securing the controls against unintended operation. Reinstall the grate before restarting the engine (Figure 25).

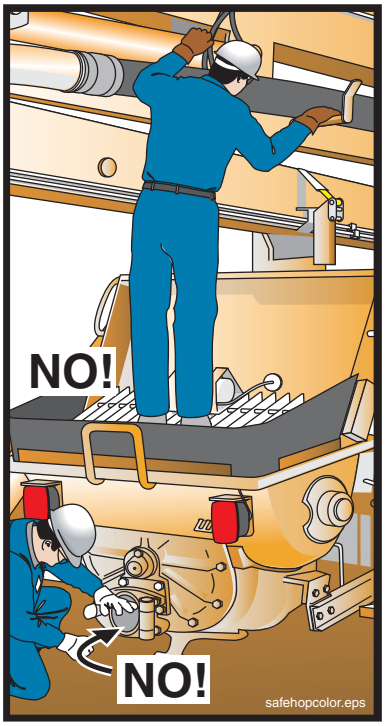


Figure 25
Keep your body parts out of the machine

9. Safety Rules For Cleaning The Water Box

9.1 **⚠WARNING** Crushing and amputation hazard! Stop the concrete pump before removing the water box covers. If your unit has bolt down guards, do not remove them for cleaning. If there is not a bolt-down guard over the water box, then stop the pump, take the transmission out of gear, and lock the cab so the pump cannot be restarted until you are finished cleaning and the covers are back in place. If a bolt-down grate is installed, you may simply stop the pump from stroking before removing the water box covers. Replace the covers before restarting the pump.

9.2 **⚠WARNING** Falling hazard! Be sure of your footing when cleaning the water box.

9.3 **⚠WARNING** Crushing and amputation hazard! Do not remove the water box guards for cleaning. Clean the water box with water jets only. **Do not put your hands or any other body part into the water box for cleaning, or at any other time when the hydraulic system is operational.**

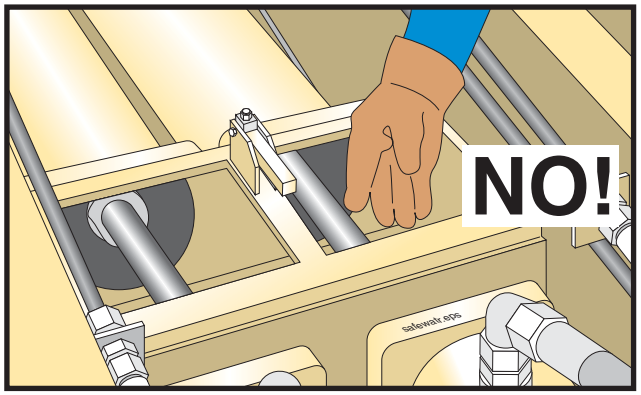


Figure 26
Keep your hands out of the waterbox

10. Safety Rules For Cleaning A Separately Laid Pipeline

10.1 **⚠WARNING** Flying particle hazard! Clear the discharge area of personnel and equipment before forcing a ball or go devil through the pipeline, even if you are cleaning with water. Some air will be trapped in the pipeline, and the trapped air will become compressed before discharge.

10.2 **⚠WARNING** Using compressed air to clean the delivery system should only be done when no other method is practical or as recommended by the manufacturer.

10.3 **⚠WARNING** The point of discharge must be controlled. Use a ball catcher or some other containment device at the point of discharge, even when cleaning with water.

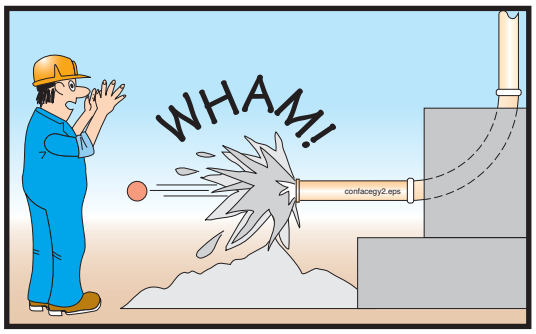


Figure 27
Cleaning with compressed air can be extremely hazardous if you don't follow the safety rules

10.4 **⚠WARNING** If you have to use compressed air for cleaning the line you **must** have all of the necessary accessories. Read and understand the complete safety rules regarding cleaning out with compressed air in this section of the Safety Manual starting at paragraph 10.8 on page 30. Cleaning with compressed air should only be done by qualified people.

10.5 **⚠WARNING** If the ball or go devil doesn't come out of the delivery system after applying compressed air, **you must relieve the pipe of air pressure before opening it.** If the bleed off valve plugs when you are draining the air, the only safe way to proceed is to drill small holes into the pipeline, which will then allow the air to escape. Wear a full face shield when drilling the holes. Pipe you have drilled into is ruined and must be replaced. Drill the holes to relieve the air pressure even if the concrete has set up in the pipe. The pipe is hazardous until the pressure is relieved.

10.6 **⚠WARNING** Exercise care when "tapping" on the pipeline to find the location of the cleanout ball. Applying too much force will dent a single wall pipe (making it weak and unsafe) and could break the carbide insert of double wall pipe.

10.7 **⚠WARNING** It is better to let the pipe be ruined by setting concrete than to risk injury by ignoring safe procedures. Remember, pipeline is replaceable, you are not.

10.8 **⚠WARNING** **Blowing out with compressed air creates potential hazards! Serious injury or death could result** if you do not adhere to these safety points.

- **Blowing out must be performed under the supervision of a qualified person.** (See the glossary for the definition of *qualified person*.)
- **Blowing out requires two people!** One trained person must be at the inlet end to operate the air insertion, and the other trained person must be near (but safely back from) the discharge point to monitor the discharge and to make sure that no one enters the hazard area.
- **No pipe bends or flexible delivery hoses may be connected to the end of the pipeline during the blowing out process,** unless there is a pre-planned cleanout station erected to route the discharge into the ready mix truck.

- **The point of discharge must be controlled. Clear the discharge area of personnel and equipment** before beginning the blowing out process. Do not allow anyone to enter the area during the blow out process. If a ball catcher is used, be aware of which type you have, and adjust your procedure accordingly. Ball catcher types are described in paragraph 5.23 on page 17.
- **The concrete outlet must be positioned high enough to permit easy discharge of the material.**
- If you are going to divert the discharge into a discharge pipe system, **you must lubricate the discharge line with slurry, or a plug could occur.**
- **The pipe cleaning blow out head must be equipped with a properly sized air discharge regulator valve and a separate water/air inlet.** The two openings should be spaced apart far enough that a blowout ball could not cover both openings at once (Figure 28).

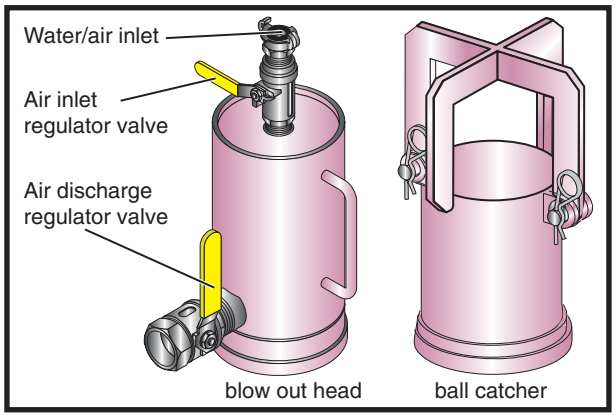


Figure 28
Ball catcher and blow out head

- The plug or go devil must be thick enough to prevent compressed air flow around the plug into the concrete.
- **The pipeline must not be disassembled until it has been completely relieved of air.** Be **sure** of this! (See Figure 29.)

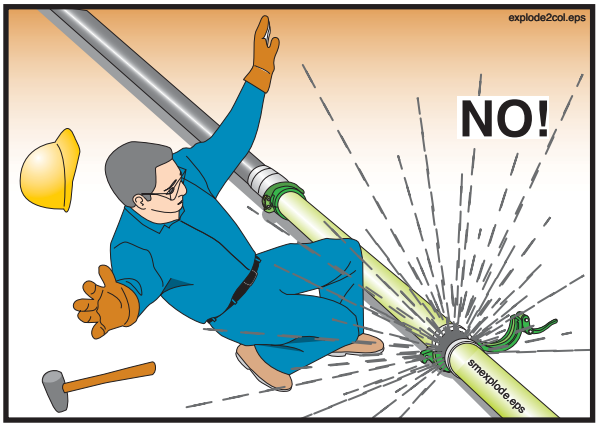


Figure 29
Never open a pressurized pipeline

- **Do not use compressed air to blow out concrete delivery hose, single pipe sections and short pipelines up to a length of 40 feet.** Hoses will jump and move unpredictably; short pipelines don't have enough concrete to resist the force of the air, causing it to discharge too quickly, like a cannon (Figure 30).

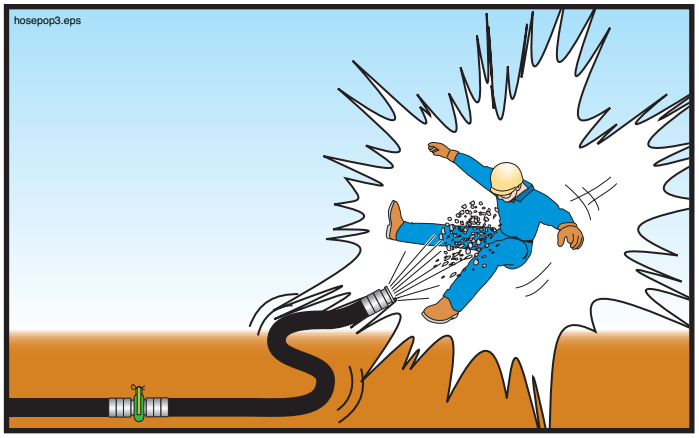


Figure 30
Never use air to blow out hoses or short pipelines

- **When air pressure begins to drop rapidly, shut off the air supply from the compressor, and immediately begin bleeding air out of the pipeline.** (The drop in pressure signifies that the pipeline is almost empty of concrete.)

10.9

⚠WARNING When blowing out a vertical line, a shutoff valve is required to prevent the following scenario.

1. (See diagram A in Figure 31.) Without a shutoff valve installed, the pipeline is disconnected from the pump. Immediately, the concrete drains out of the vertical sections of pipe, leaving concrete in both horizontal sections, and air trapped in between.
2. (See diagram B in Figure 31.) The ball is inserted, and pushed with compressed air. This also compresses the air that is trapped in the vertical sections of pipe. The trapped air will be violently expelled when it reaches the end of the pipe, but the pipe will not yet be empty.

A shutoff valve installed at the bottom of the vertical run will prevent this hazardous situation. The shutoff valve must be capable of handling the maximum concrete pressure of the pump and, of course, must be installed before the pour begins. Several different styles are available, ranging from a manually operated flat gate that is put into place with a hammer to fully hydraulic types that will also divert the concrete to a different pipeline. With a shutoff valve installed, you can proceed as indicated below.

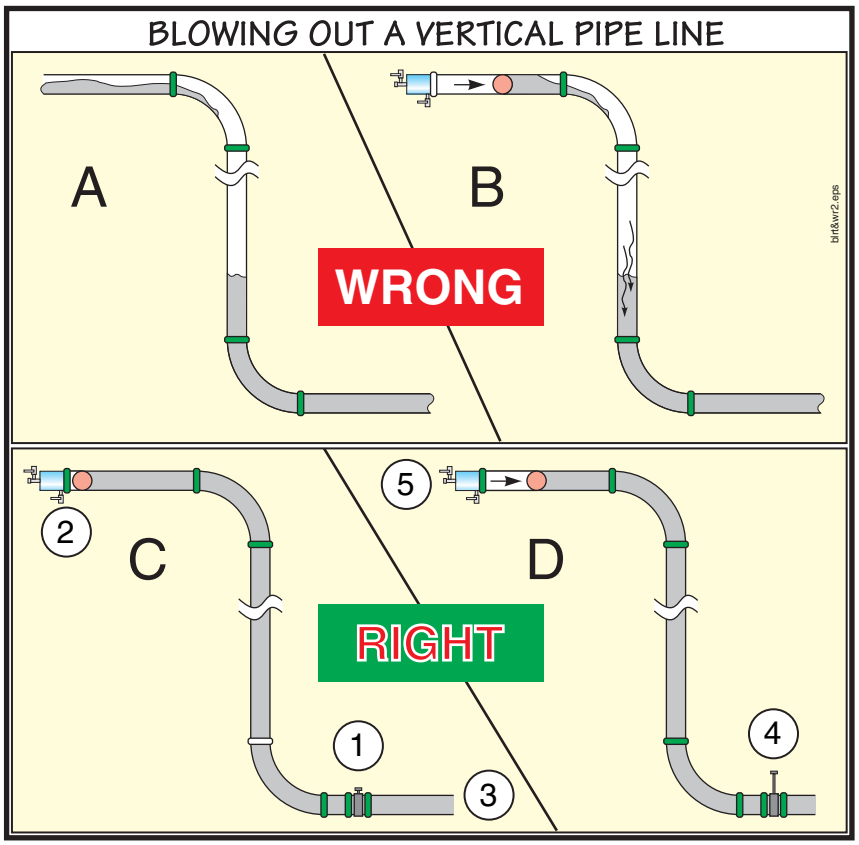


Figure 31
Blowout of a vertical line

10.10 **⚠WARNING** **Blowing out vertical sections of pipe** (for example on a high rise building) **requires additional safety precautions.**

1. **Know where the discharge area for blowing out will be before the pour begins.** Ready the area and accessories before the pour begins so you will not waste time when pumping is completed.
2. **Blowing out with compressed air requires two qualified persons.**
3. **The persons at both ends of the pipeline must be able to communicate without delays,** which means you must establish communications (for example, with a radio).
4. **When pumping is complete, close the shutoff valve before disconnecting the pipeline from the pump** (item 1, Figure 31). Failure to do this will cause the concrete to fall out of the vertical sections of pipe, leaving concrete in the horizontal sections of pipe and an air pocket in the vertical sections. This does not apply if you are using a switching (diversion) valve.
5. Install the ball(s) in the pipeline, secure the blow out head and hook up the air compressor. **Do not apply the air yet!** (Item 2, Figure 31.)

6. If you will be diverting the discharge to a cleanout area, lubricate the discharge line with slurry, or a plug could occur.
7. **Position the ready mix truck at the cleanout standpipe,** or install the ball catcher or other containment device at the end of the discharge line. (Item 3, Figure 31.)
8. **Clear the discharge area of personnel.** You must allow no one to enter the discharge area until the pipeline is depressurized.
9. **Divert the vertical pipe line to the clean out area and secure the discharge (Figure 32), or open the shutoff valve in the delivery pipe line now.** Allow gravity to start the concrete moving through the discharge line. As the concrete falls from the vertical sections, it will take the ball with it, making it impossible to trap air in the line. (Item 4, Figure 31.)

Figure 32
Divert vertical pipeline to the cleanout area and be sure to secure the discharge before continuing

10. **Apply the compressed air to the pipeline.** Close communications must be maintained at this time. Add only enough air to keep the concrete moving. Do not allow the concrete to accelerate. (Item 5, Figure 31.)
11. **When concrete starts to accelerate, shut-off the air supply from the compressor, and open the air regulator to bleed air from the line.** Rapidly accelerating concrete indicates that the pipeline is almost empty. After the ball has been expelled from the pipeline, leave the air regulator open to be sure that all air is removed from the system.
12. All the rules for blowing out found in point 10.8 on page 30 also apply to blowing out a vertical pipe line. These rules are in addition to the general "cleaning a pipeline with compressed air" rules.

10.11 **⚠WARNING** **Never use compressed air to attempt to clear a blockage!** It is unsafe and unnecessary. If the pump pressure can't move it, air pressure won't either.

V. Maintenance Of The Machinery

11. Safety Rules Regarding Inspection

11.1 **⚠WARNING** Visually inspect your unit each day before it is put into operation. If any problem is found that will affect the safe operation of the pump, don't use the pump until it is repaired!

11.2 **⚠WARNING** If safety decals are faded, missing, damaged, or otherwise unreadable, they must be replaced immediately. Contact the manufacturer of your unit to obtain replacements.

11.3 **⚠WARNING** If safety devices or guards are removed for inspection purposes, they must be replaced before someone uses the machine.

11.4 **⚠WARNING** Pay attention to the *Operation Manual* and manufacturer's service bulletins regarding maintenance and inspection procedures and intervals.

11.5 **⚠WARNING** If inspection reveals something that looks wrong, or even suspicious, report it to the manufacturer for consideration. Don't just assume that it's OK.

11.6 **⚠WARNING** Visual inspection of the concrete pump circuits and safety devices should be done daily. Hands on inspection and documentation of results should be done weekly, or at least when preventive maintenance is scheduled.

11.7 **⚠WARNING** Do not neglect the delivery pipeline, clamps, or hoses. Check them often for wear, dents, and frays. Never send a unit to a job with a worn or damaged delivery system. For single wall pipes, ultrasonic thickness testers are more accurate than the tap method.

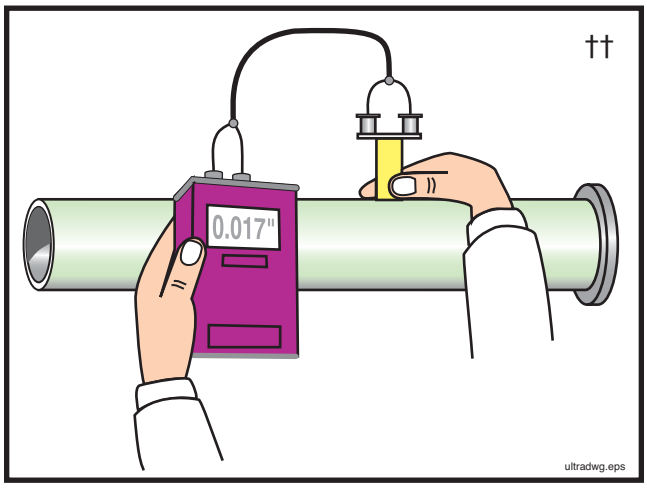


Figure 33
Check delivery system wall thickness with an ultrasonic thickness tester

12. Safety Rules Regarding Scheduled Maintenance

12.1 **⚠WARNING** Proper and timely maintenance is important to the safe operation of a concrete pump. The proper procedures are outlined in the *Operation Manual* supplied with the pump. Do not put it off. Do not treat it lightly. Do not "fudge" results. The lives of the operator, oiler, and workers on the job are depending on it.

12.2 **⚠WARNING** Keep the machine clean! Oil spills, grease, loose tools, and displaced accessories are hazards.

12.3 **⚠WARNING** Pins should be used on all delivery system clamps. Clamps that will hang over workers, and clamps used on system that will be dragged shall be pinned (Figure 34).

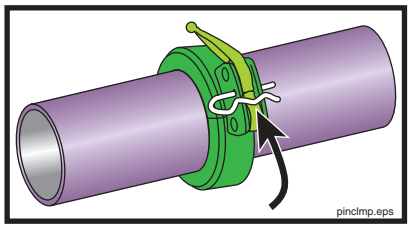


Figure 34
Pin the clamps

12.4 **⚠WARNING** Be sure that you are installing the correct clamps for the types of pipe ends used. Never try to mate dissimilar pipe ends unless using a clamp specifically made for this purpose. See the comparison regarding weld-on ends on page 50 in the *Appendix* of this manual.

12.5 **⚠WARNING** When using new pipe and/or hose on the machine be sure that it is capable of handling the maximum concrete pressure of the pump. (removed text)

12.6 **⚠WARNING** If safety devices or guards are removed for servicing, they must be replaced before the machine is put back in service.

12.7 **⚠WARNING** Do not change the maximum relief valve setting on any hydraulic circuit without permission from the manufacturer. **Never** change an accumulator circuit pressure setting without specific instructions from the manufacturer.

12.8 **⚠WARNING** Never make unauthorized modifications to structural members or pressure circuits.

12.9 **⚠WARNING** You must **replace, not repair** damaged hydraulic or concrete hoses or pipes.

12.10 **⚠WARNING** Never try to repair a machine using worn, damaged, or defective components.

12.11 **NOTICE** **Never allow welding current to travel through bearings or hydraulic cylinders.** Keep the ground cable on the component that is being welded.

12.12 NOTICE **Electronic components can be destroyed by welding current.** Before welding on the unit, you must disconnect the battery cables, and unplug all radio remote control power wires. If in doubt, contact the Service Department of the manufacturer for instructions **before** proceeding.

13. Safety Rules When Servicing The Machinery

13.1 ⚠WARNING **Repairs should be carried out by qualified workshop personnel.** (See the glossary for the definition of *qualified personnel*.)

13.2 ⚠WARNING **Read and understand the maintenance procedures in the *Operation Manual* of the machine before attempting any repairs.** If in doubt, call the manufacturer. Incorrectly done repairs affect the safe use of the machine.

13.3 ⚠WARNING Burn hazard! **Never work on a hot hydraulic system.**

13.4 ⚠WARNING Falling hazard! If you cannot work at ground level, you must find and use a suitable work platform, a tie-off harness system, or otherwise secure yourself from falling.

13.5 ⚠WARNING If maintenance work requires that you use a crane, hoist, fork truck, or similar machine, read and understand the safety regulations for that equipment.

13.6 ⚠WARNING **Only operators should operate the unit.** If work on the machine requires that it be operated and you are not qualified as an operator, you must get someone who is qualified to assist you.

13.7 ⚠DANGER Electrocution hazard! **Repair work on high voltage electrical systems must be done by qualified electricians.** For this rule, high voltage means anything over 24 volts.

13.8 ⚠WARNING Explosion hazard! **Be sure that you understand the potential danger of spring loaded or compressed gas components before you service them.** (Examples: nitrogen accumulators, gas springs for toolbox doors, tires, brake chambers.) If you don't know the dangers, call the manufacturer **before** beginning work!

13.9 ⚠WARNING If you will be working in a hidden area inside the machine, lock it out as follows.

- With a gas or diesel engine, remove the ignition key and place a *Do Not Operate* sign on the controls. Carry the key with you.
- With an electrically driven pump, lock out the main breaker and tag the controls.

The above rules are one simple "Lock Out-Tag Out" procedure. A procedure may also be provided in the operation manual for the unit and there may be state or local regulations that require a more advanced or stringent Lock Out-Tag Out program. Be aware of the regulations in your area.

13.10 **WARNING** **Never activate the system hydraulics without checking if another workman is in a hidden position.** Always yell "clear" before starting the engine or electric motor, and allow time for response.

13.11 **WARNING** **Never work on a pressurized hydraulic system.** Stop the engine or electric motor and relieve the accumulator circuit (if so equipped) before you open the hydraulic system.

13.12 **WARNING** **Never use gasoline or diesel fuel as a cleaning solvent.** This is critical to remember when cleaning hydraulic oil reservoirs, because gas and diesel fuels are highly explosive and **traces left in the oil may ignite when compressed!**

13.13 **WARNING** Remember to mount and dismount the unit using the "3 Point Rule." One hand and two feet or two hands and one foot are to be in contact with a secure surface at all times (Figure 35).

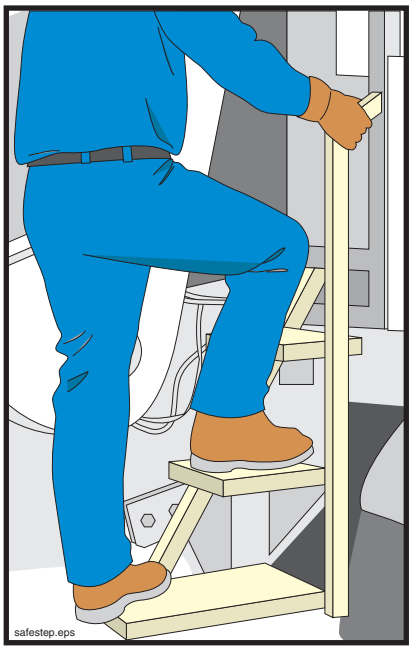


Figure 35
The 3 Point Rule

13.14 **WARNING** **Always use the correct tools for the job.** Tools should be kept clean and in good condition.

13.15 **WARNING** If you see a co-worker engaging in an unsafe practice, warn him about the dangers. Safety is always in the hands of those on the job!

13.16 **WARNING** After any repair is completed, test the function of the repaired part to be sure that repairs were done correctly.

VI. Co-worker Safety

14. Safety Rules For Workers Assigned To The Pump.

14.1 **⚠WARNING** **You must know how to stop the pump.** Have the operator show you the locations of the emergency stop switches (Figure 36).

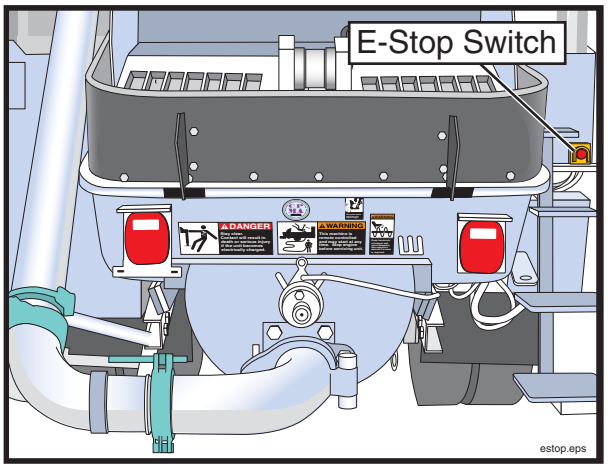


Figure 36
Know how to stop the unit in an emergency

14.2 **⚠ DANGER** **You should wear the same personal protective equipment as the operator.** Goggles, hard hat, ear protection, and rubber gloves are especially important when working near the hopper, (Including *full face shield or * breathing mask where necessary, as shown in Figure 37).

* Breathing mask needed when cement dust (or other toxic dust) is present in the air.

* Full face shield is needed when shotcreting or any time material being placed is rebounding.

Figure 37
Wear the same personal protective equipment as the operator

14.3 **⚠WARNING** **Crushing hazard. Never, ever position yourself between the ready mix truck and the pump!** Stand to the side, where the driver can see you (Figure 38).

Figure 38
Never stand between the ready mix truck and the pump

14.4 **⚠WARNING** When backing in ready mix trucks, use clear and concise hand signals (Figure 39).

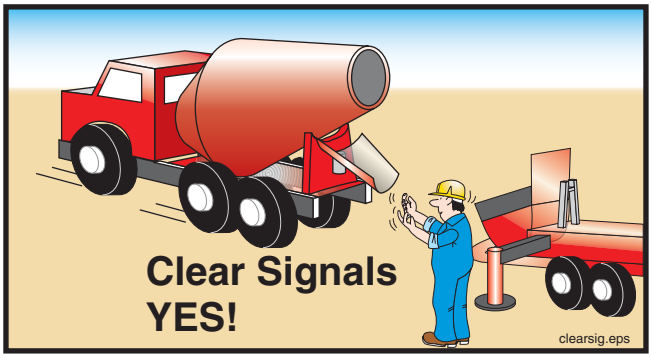


Figure 39
Use clear, concise hand signals

14.5 **⚠WARNING** If handling the chutes of a ready mix truck, keep your hands clear of the hinged areas.

14.6 **⚠WARNING** Do not allow the ready mix driver to put concrete in the pump hopper until the pump operator gives him the OK. Filling the hopper early can cause the pump to plug.

14.7 **⚠WARNING** If you see foreign material that could create a blockage coming from the ready mix truck, alert the operator to stop the pump. Do not attempt to remove the material from the hopper or grate while the hydraulic system is ready to work. (See point 14.16 on page 43.) If necessary, depress the E-stop button to stop the pump and alert the operator.

14.8 **⚠WARNING** **Never allow the ready mix driver to clean out in the hopper,** because it can create a blockage. (Water will wash the cement and fine sand from the course aggregate causing segregation.)

14.9 **⚠WARNING** Do not operate the pump unless you are also a trained operator and the regular operator has released the controls to you. **There must not be more than one operator at a time.** This does not apply to stopping the pump or boom if there is a need to do so.

14.10 **⚠WARNING** Do not let the concrete level in the hopper become low! If air is sucked into the material cylinders, the pump will compress the air. Compressed air always poses a hazard as it is expelled from the hopper or the delivery pipeline (Figure 40). If air is taken into the material cylinders, take the following steps to minimize the hazard:

1. Stop the pump immediately. Hit the emergency stop button if that is the quickest way to stop the pump. There will be an expulsion of compressed air the next time the concrete valve shifts. If possible, fill the hopper with concrete to help contain the expulsion. Do not put your face directly over the hopper.
2. Alert the operator of the problem. It is his job to know the procedures for safe removal of air from the pump and delivery system. These procedures include pumping in reverse for a couple of strokes.
3. Persons standing at the discharge end or near the delivery line must be warned to move away until all of the air has been purged. Warn them to stay a reasonable and prudent distance beyond the reach of the end hose or point of discharge (Figure 40).
4. When the pump is restarted, don't assume that the first little air bubble is the end of the compressed air.
5. Do not allow anyone near the discharge until concrete runs steadily from the end and there is no movement of the delivery system.

- If workers are positioned in high or precarious places, warn them to expect a loud sound as the air escapes the pipeline. (Warn them even if they are well away from the discharge.) That way, we can prevent the worker from falling as a result of being startled by the noise.

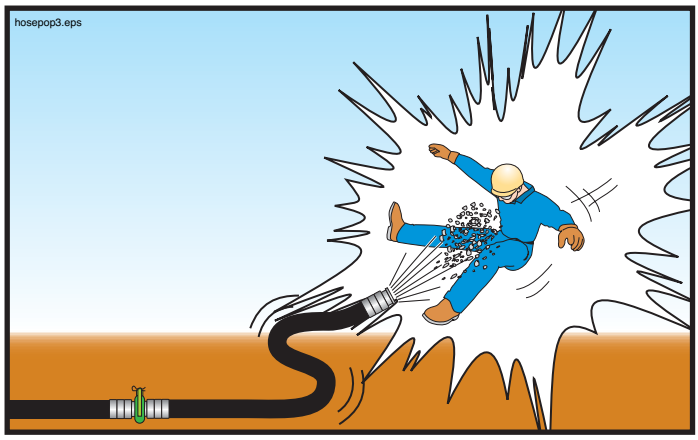


Figure 40
Remove everyone from the discharge area whenever the pump is first starting, restarting after moving, or if air has been introduced into the line

14.11 **⚠WARNING** When initially priming the delivery system, when restarting after moving, when restarting after adding or removing hoses, or whenever air has been introduced into the line, warn everyone to stay away from the discharge until concrete runs steadily and there is no movement of the delivery system. Personnel should stay back a reasonable and prudent distance beyond the reach of the end hose or point of discharge (Figure 40). Air will be in the line when first starting, when restarting after moving, when a blockage has been successfully removed by "rocking" the concrete, and after the line has been taken apart or opened for any reason.

14.12 **⚠WARNING** **Never use compressed air to clear a blockage!** The operator is responsible for knowing the safe blockage removal procedures. It is unsafe and unnecessary to use compressed air. If the pump pressure can't move it, air pressure won't either.

14.13 **⚠WARNING** Never stand on, sit on, or straddle a pipeline while it's in use, or whenever it is pressurized. Pipeline wears out with each stroke of the pump. If the pipe bursts, you want to be to the side of it, not on top of it (Figure 41).

Figure 41
Never straddle or sit on a pressurized pipeline

14.14 **⚠WARNING** Expulsion hazard! **Never open a pipeline that is under pressure** (Figure 42). The pump must be run in reverse for at least two strokes and then stopped before opening a pipeline. If the pipeline is pressurized with air, do not open it. The operator is responsible for knowing how to safely release the air pressure.

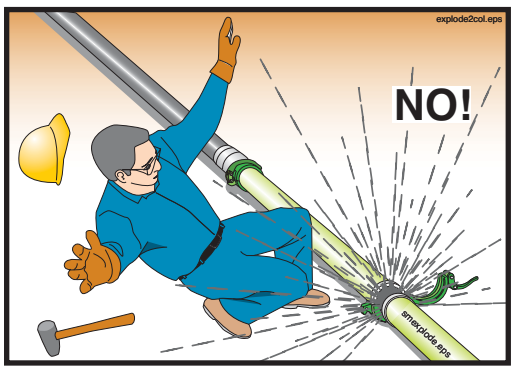


Figure 42
Never open a pressurized pipeline

14.15 **⚠WARNING** Be careful when handling pipeline or any other heavy object. Learn how to lift without using your back. Get assistance if needed.

14.16 **⚠WARNING** Crushing/amputation hazard! Never put your hands, feet, or any other body part into the water box, concrete valve, or hopper when the hydraulic system is operational or ready to operate! Never stand on the hopper grate! (See Figure 43.)

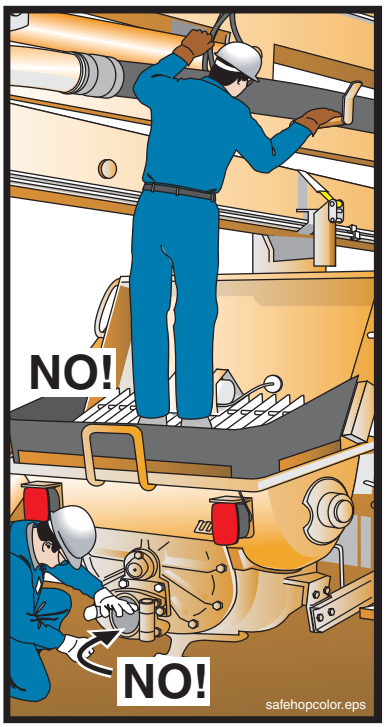


Figure 43
Never put your body in the machine!

14.17 **⚠WARNING** Never lift or remove the hopper grate for any reason (Figure 44).

Figure 44
Lifting hopper grate exposes the agitator and the concrete valve

14.18 **⚠WARNING** Do not remove the water box covers or grates when the machine is stroking (Figure 45). Do not remove the water box cover (to add water, for example), until the operator has disabled the machine. Replace the covers before the operator restarts the pump.

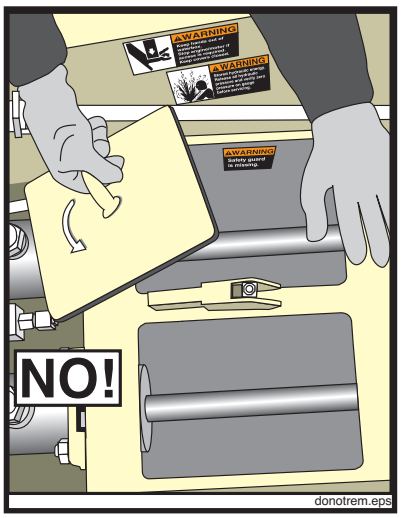


Figure 45
Do not remove the water box covers when the machine is stroking

14.19 **⚠WARNING** Mount or dismount the pump or truck using the *3 Point Rule.* One hand and two feet or two hands and one foot are to be in contact with a secure surface at all times (Figure 46).

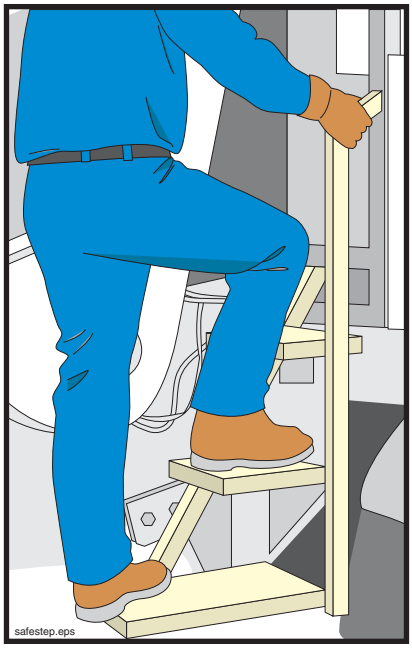


Figure 46
The 3 Point Rule

14.20 **⚠WARNING** Keep unauthorized personnel off of the pump.

15. Safety Rules For The Placing Crew

15.1 **⚠WARNING** Wear Personal Protective Equipment (P.P.E.) when working around a concrete pump (Figure 47). The gloves should resist concrete lime burns. If you will be working **in** the concrete, protect your feet and hands with rubber boots and gloves (including *full face shield or * breathing mask where necessary, as shown below).

* Breathing mask needed when cement dust (or other toxic dust) is present in the air.

* Full face shield is needed when shotcreting or any time material being placed is rebounding.

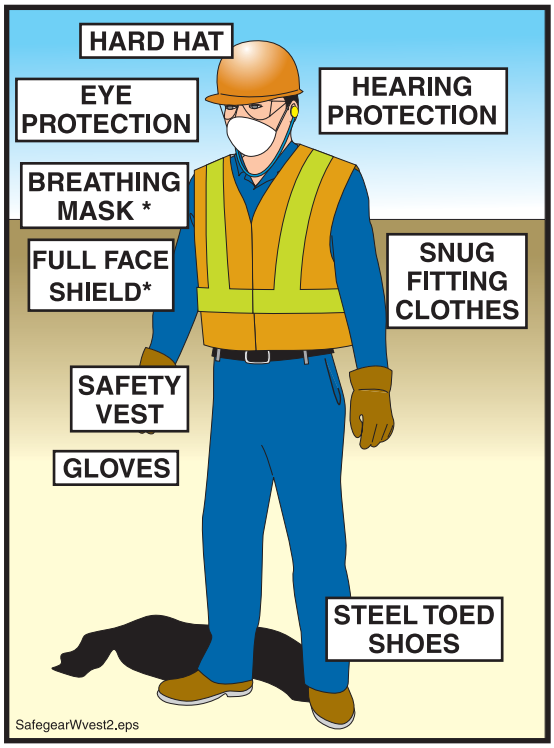


Figure 47
Wear Personal Protective Equipment (P.P.E.)

15.2 **⚠WARNING** When the operator is initially priming the delivery system, restarting after moving, restarting after adding or removing pipes or hoses, or any time that air has been introduced into the delivery system, stand a reasonable and prudent distance away from the tip hose or point of discharge. Do not get near the discharge until material runs steadily and there is no movement of the delivery system. (Figure 48). Compressed air in the line can cause rubber hose to move violently. If the operator tells you that air is coming in the delivery system, proceed as follows:

- Get to ground level (if in a high place) and remain well away from the discharge or at least take cover.
- Stay away from the discharge. Be sure that **all** the air is gone before getting near the point of discharge again. It is the operator's job to know when it's safe to go back to normal pumping.

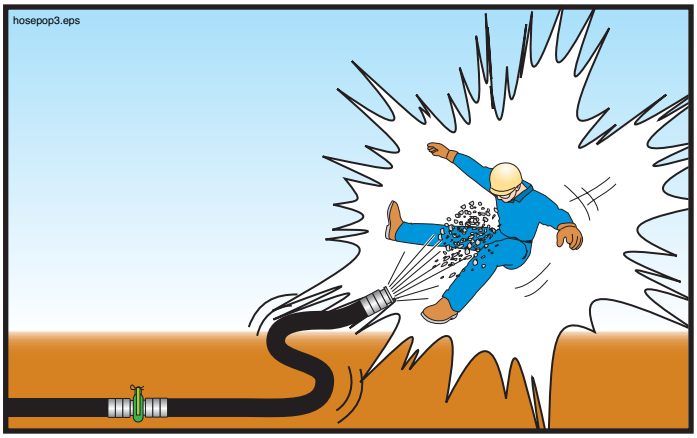


Figure 48
Stay away from the point of discharge when starting or restarting, and when there's air in the pipeline

15.3 **WARNING** **Never use compressed air to clear a blockage!** It is unsafe and unnecessary. If the pump pressure can't move it, air pressure won't either. Stand away from the discharge and the line if anyone attempts to use compressed air in this manner.

15.4 **WARNING** **Do not look into the end of a plugged hose or pipe!**

15.5 **WARNING** When the pump crew is using compressed air to clean the boom or system pipeline, stay away from the discharge area. **Never try to hold down a pipe or hose that is being cleaned with air.**

15.6 **WARNING** Never open a pressurized pipeline (Figure 49). The pump operator must release the pressure before you open the line. If the line is pressurized with compressed air, let the operator release the pressure and verify that the air has escaped before you proceed.

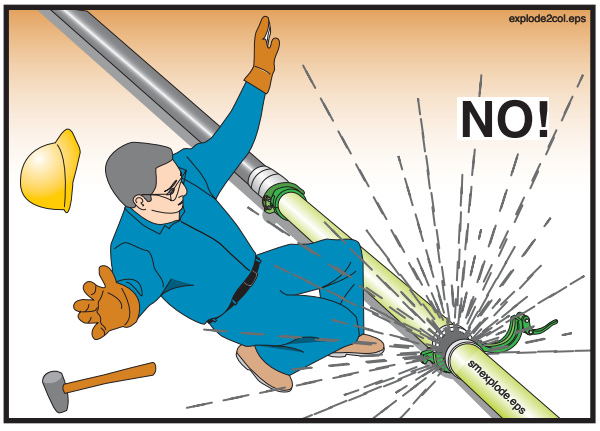


Figure 49
Never open a pressurized pipeline

15.7 **⚠WARNING** After removing pipe sections you must **reassemble using gaskets and clamps.** Pipelines assembled without gaskets will leak cement and water, which can cause a blockage.

15.8 **⚠WARNING** Concrete is being moved through the delivery system by pressure. Failure of a pipe, clamp, hose, or elbow is possible. For this reason, spend as little time as possible standing near the pipeline, and wear protective clothing.

15.9 **⚠WARNING** Do not kink the end hose. Kinking will cause the pump to create maximum concrete pressure. The pump may unkink the hose by force! (See Figure 50.)

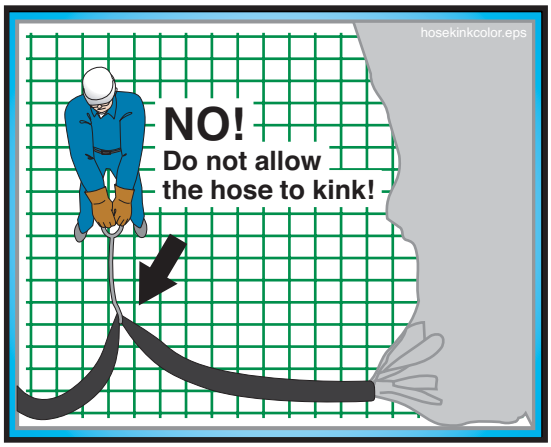


Figure 50
Never kink the hose; Never hold the hose with your shoulder

15.10 **⚠CAUTION** Be careful when handling pipeline or any other heavy object. Learn how to lift without using your back. Get assistance if needed.

15.11 **⚠WARNING** Falling hazard! When pouring columns, slabs, or walls above ground, secure yourself from falling.

15.12 **⚠WARNING** Never stand on, sit on, or straddle a pipeline while it's in use, or whenever it is pressurized (Figure 51). Pipeline wears out with each stroke of the pump. If the pipe bursts, you want to be to the side of it, not on top of it.

Figure 51
Never straddle or sit on a pressurized pipeline

15.13 **⚠WARNING** To avoid confusion and conflicting signals, only one person should signal the pump operator except for the stop signal.

15.14 **⚠WARNING** Before the pour begins, the hose man and the operator should agree on the hand signals (Figure 52).

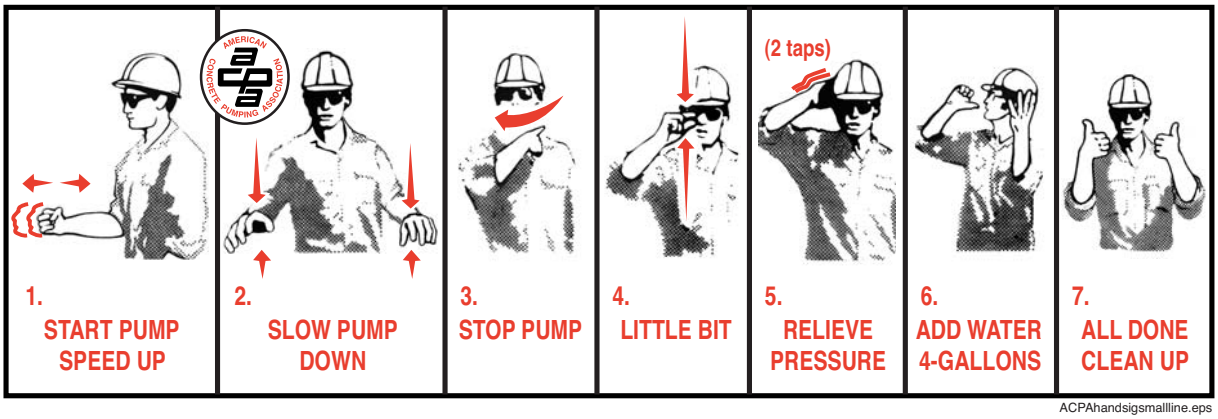
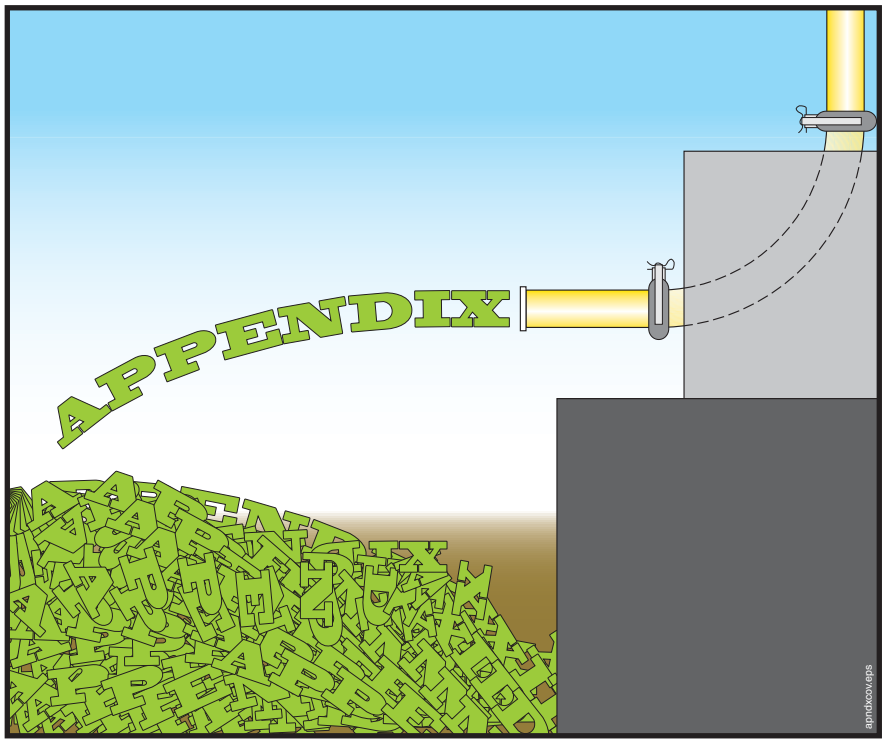


Figure 52
Recommended ACPA hand signals



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VII. Weld on Ends and Coupling Comparison

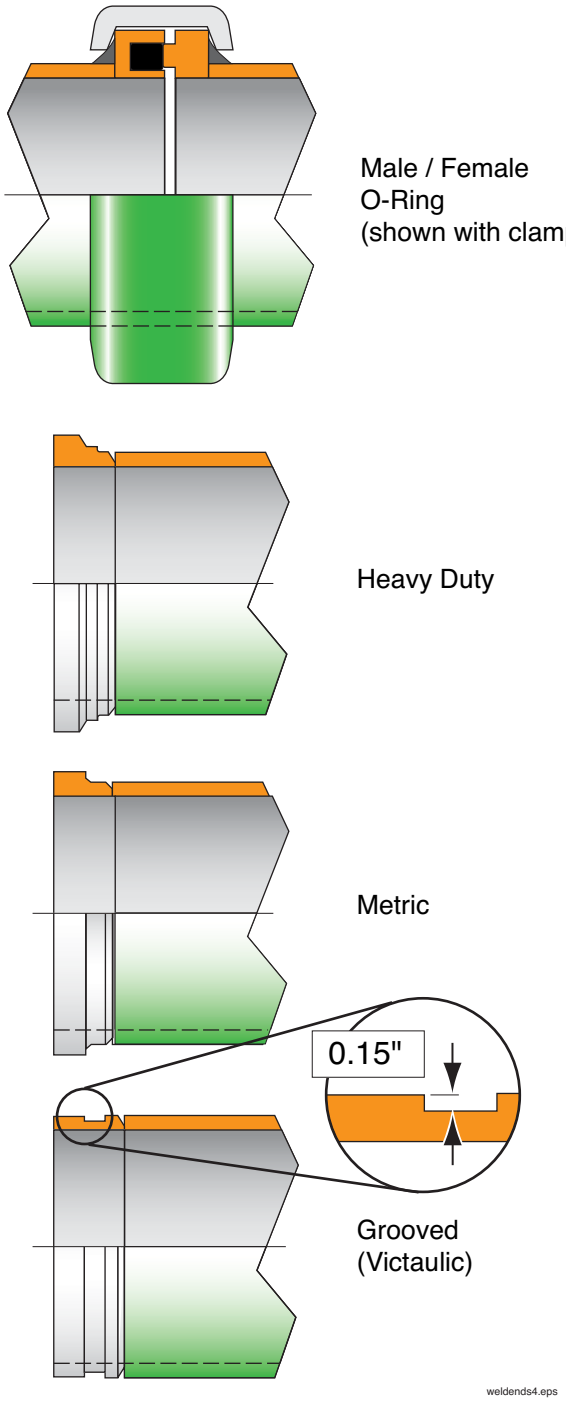
Shown is a comparison among commonly used ends/couplings. No two ends shown can be joined without the use of an adapter pipe or a special adapter clamp. Clamps and pipe strength must also be considered when determining proper system requirements. The ratios shown in the text below represent the safety factor from burst : working pressures.

1. Male / female o-ring type couplings have the highest pressure rating of the ends commonly used for concrete pumping. They can withstand 4350 PSI @ a 2:1 safety factor. They are self aligning and waterproof when used with o-rings in good condition. Typically not used on booms because of their weight. Pipes equipped with this style coupling cannot be swapped end-for-end.

2. Heavy-Duty couplings are designed for pressures up to 2250 PSI @ 2:1. They have 20% more contact area than metric couplings, and a tapered face that draws the pipe sections together during assembly. Both the ends and clamps weigh more than metric style, and therefore should not be used on booms without consulting the manufacturer.

3. Metric couplings are designed for pressures up to 1400 PSI @ 2:1. They have 85% more contact area than grooved couplings. The face is flat and will not draw pipe together. Although they have a raised edge, they are not compatible with Heavy Duty couplings unless a special clamp or an adapter pipe is used to change from one style to the other. Metric connections are standard equipment on booms because of the weight savings compared with other styles.

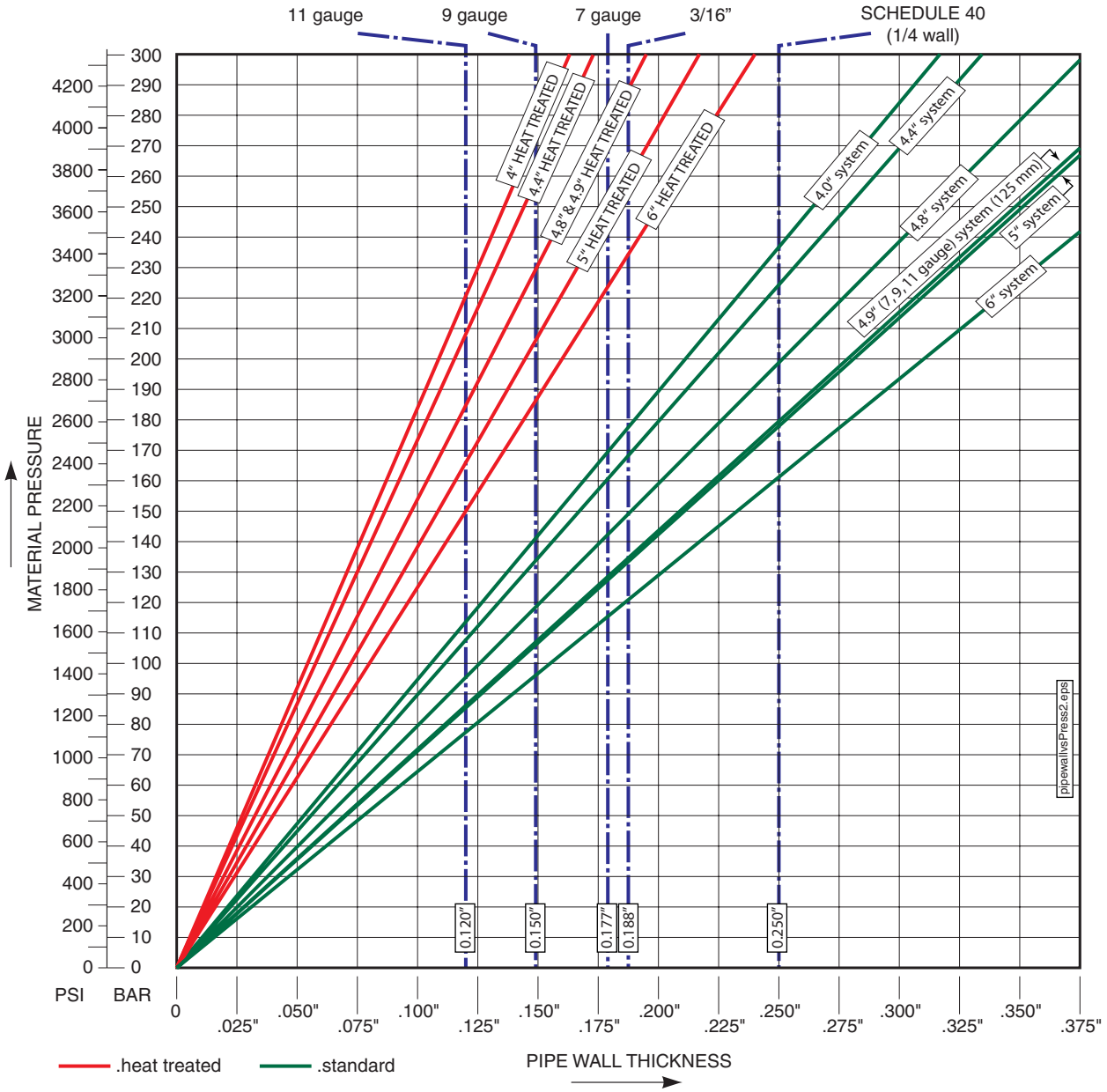
4. Grooved couplings (lip height of 0.15” or less) are designed for pressures only up to 750 PSI @ 2:1. The recessed groove is hard to clean when changing pipe on a job. The weld-on end fails before the pipe because the groove is cut into the pipe thickness, making it the weakest spot. Grooved couplings are not recommended for concrete pumping applications.



NOTE: All pressure ratings listed refer to 5 inch (125mm) diameters in like-new condition. Other pressures would apply to other sizes.

VIII. Pipe Wall Thickness Chart

Minimum Pipe Wall Thickness As a Function of Pressure



1. This chart assumes a safety factor of 2:1. Higher safety factors may be required in some circumstances.
2. Wear reduces wall thickness. Thickness must be checked on a regular basis.
3. Pressures may be limited even more by clamp style or pipe end used.
4. The chart is based on 62,000 PSI tensile strength. Heat-treated calculations are based on 120,000 PSI tensile strength.
5. The chart is for pressure calculations ONLY. There is no allowance for mechanical forces other than pressure, and thicker walls may be needed for mechanical strength because of support or restraint considerations.
6. The chart does not take into account metal fatigue caused by pressure cycles.

Note! This chart is intended as a guide for concrete pumping applications and is subject to the notes, assumptions, and conditions listed above. Any other use of this chart is not recommended.

This chart does not apply to double-wall pipe. Double wall pipe can be checked by inspecting the inside of the pipe. If the insert is intact, the pipe is okay. If the insert is worn through, the pipe must be replaced. Contact your pipe supplier for the pressure capacity of your double-wall pipe.

IX. Glossary Of Terms

Accumulator

A hydraulic device that stores fluid power energy in much the same way that a battery stores electrical energy. Because an accumulator will store energy, it MUST be drained and depressurized before work begins on an accumulator equipped actuator or hydraulic system.

Agitator

A device that sits in the concrete hopper to keep concrete moving, preventing it from setting. It is typically a rotating shaft to which several paddles have been mounted. *See Also:* Hopper Grate

Blanking Plate

Also known as a blanking plug or end cap. It's purpose is to prevent material from falling out of the delivery system when moving a boom with a full pipeline over personnel or property.

Blockage

Simply put, if the pump is pushing and concrete fails to come out at the point of discharge, it is called a blockage. Blockages can be removed with pump pressure, by rocking the pump between forward and reverse, or some other remedial measure. If the blockage can not be removed in such a manner, it's called a plug. *See Also:* Plug, Rock Jam. The causes of blockages are detailed in section 6.13 of this manual. In all cases, blockages create a hazard by causing high concrete pressure, combined with the sometimes uncoordinated efforts of untrained workmen to remedy the problem.

Bulk Density

The mass of a substance per volume. For example, one cubic foot of air weighs much less than one cubic foot of water. One cubic foot of lightweight concrete weighs less than one cubic foot of steel entrained concrete. We could say that steel entrained concrete has a higher bulk density than lightweight concrete. All calculations for the operation manuals and specifications of concrete pumps are based upon 150 pounds per cubic foot, which is the approximate mass of hard rock (normal) concrete.

Certified Operator

An operator that has been issued a certification card by the American Concrete Pumping Association. There are several classes of certification, each relating to a different category of pump. For an operator to become certified, he (she) must pass the written tests regarding operation, setup, and clean out for each category of pump, pass the safety rules test which is common to all certification categories, meet the experience requirements set forth for each category, and maintain a safe and clean driving record. The certification card only certifies that the operator has passed a written test administered by an A.C.P.A. certification tester and does not attest to their ability to operate a concrete pump. *See Also:* Qualified Person, Qualified Operator.

Concrete Delivery Hose

A flexible concrete hose that has two end couplings.

Concrete Pressure

The force per square area that is exerted on the concrete. The concrete pressure will always be a ratio in direct proportion to the hydraulic oil pressure on the concrete pump circuit. *See Also*: Maximum Pressure

Conductors

Materials that will conduct electricity. Copper, silver, aluminum, gold, steel, and water are considered GOOD conductors of electricity. Air, fiberglass, rubber, ceramics and glass are considered POOR conductors. All of these conductors have a resistance to the flow of electricity that can be measured in terms of ohms per linear foot. As voltage gets higher, more current flows through the same resistance. In the case of high voltage electric wires (8000 volts, for example) even the poor conductors will carry enough current through your body to ground that you could be killed. (As little as 35 milliamps can cause fibrillation of the heart.) Some conductors, like air, resist electricity very well, but if the voltage gets high enough, current will flow (lightning is a good example of this). *See Also:* Electrocution

Decibels

One tenth of a bel. Abbreviated dB. It is a measurement of sound volume. As it applies to concrete pumps, it is a measurement of the sound pressure level one meter away from a noise source. O.S.H.A. has developed guidelines for time limits on exposure to sound at different volume levels. The chart can be found on page 36 of this manual.

Drive Engine

The primary source of power for a hydraulic system. Typically, the word “engine” denotes and internal combustion device, whereas the word “motor” denotes an electrical device.

Electrocution

Made from the words “Electric” + “Execution.” It means death by electricity. *See Also:* Conductors

End Hose

A flexible concrete hose that has one end coupling.

Foreign Material

Material that was never intended to be pumped, which ends up in the concrete hopper. Examples of foreign material include small animals, hammers, ready mix truck fins, unmixed clumps of cement, hardened concrete that breaks away from ready mix truck fins, and soda pop cans. These items could create a blockage if pumped.

Go Devil

A plug made from a rubber composite, usually with several fins that expand to seal when pressure is applied. They are intended to be inserted in a steel delivery pipeline and pushed with water or compressed air for the purpose of cleaning the pipe. *See Also:* Sponge Ball

Guide

An assistant brought in to help in backing up a truck or trailer, or to help in other circumstances where the driver cannot see enough to assure safety. *See Also:* Spotter

High Voltage

For the purposes of this manual, anything over 24 volts is to be considered high voltage. In the U.S., electrically driven concrete pumps normally operate the motors at 480 volts AC (high voltage) and the controls at 24 volt DC (low voltage). When dealing with electric wires in residential or industrial areas the voltage will be approx. 8000 volts to ground, or 13,800 volts from phase to phase (distribution voltage). When dealing with electric wires that are mounted on steel towers high above the ground, the voltage will range from 100,000 to 1,000,000 volts (transmission voltage).

Hopper Grate

A meshwork placed over the concrete hopper, typically made from steel bars. It serves the functions of keeping human body parts away from the agitator (when left in it's proper position) and keeping large foreign objects from falling into the hopper, which could cause blockages if they were pumped.

Jacking the Outriggers

Adjustment of the outriggers in the vertical direction.

Licensed Electrician

A qualified electrician licensed by the state, county or municipality where the connections are to be made. In some locations electricians are not required to be licensed, and in these cases the work should still be carried out by competent professionals. Under no circumstances should high voltage connections be made by a concrete pump operator or related personnel.

Maintenance

All procedures for service, inspection, and repair of concrete pumps and related equipment and devices. Maintenance and inspection are methods of ***maintaining*** the desired state of the equipment. Repair is the method of ***restoring*** the desired state of the equipment.

Maximum Pressure

When talking about a hydraulic system, maximum pressure refers to the highest pressure that can be achieved with the settings of the circuit relief valves. When discussing concrete output, maximum pressure refers to the pressure that will be developed if the hydraulic system pressure reaches the relief valve setting. Concrete pressure is the force at which the differential cylinders are moving, divided by the cross sectional area of the concrete cylinder. Maximum concrete pressure, then, is developed when the differential cylinders are moving with maximum force, which is determined by the hydraulic system relief valve setting. *See Also:* Concrete Pressure.

Minimum Safety Distance

In this manual, the term "minimum safety distance" refers to the closest distance that you are allowed to approach an object, electrical wires, etc. and still leave room for errors in human judgement or machine malfunction. With electrical wires in the U.S., this distance is 17 feet, as recommended by the American Concrete Pumping Association. This distance may have other values in different locations. It is up to the operator to know the value for the place of operation.

Operational Area

The area around a working piece of equipment or point of discharge where hazards can be encountered due to the nature of the machinery or process in use.

O.S.H.A.

Occupational Safety and Health Administration. A branch of the United States federal government that deals with job safety. They establish and enforce safety regulations for industry and business. Among the areas over which they have authority are construction job sites and work shops.

Personal Protective Equipment (P.P.E.)

Things you can wear to protect yourself from potential dangers in a concrete placing environment. Examples are:

- Snug fitting work clothes
- Steel toed work boots
- Lime resistant gloves
- Safety glasses
- Ear muffs or ear plugs
- Rubber boots when you have to stand in concrete
- Hard hat
- Breathing mask when working with cement dust

Plug

A plug is a blockage that cannot be removed with the pump pressure, or by other remedial measures. A plug must be removed manually. *See Also:* Blockage.

Point of Discharge

Also known as the point of placement. The location of concrete expulsion from a delivery system. This can be the point of placement (the actual form that is being filled with concrete) or the clean out area after completion of the job.

Pour

Used by the concrete pumping industry and in this manual as a noun. It is the specific job for the pump during any given time period. (e.g. “We’ll grab lunch right after the pour.”)

Qualified Person

As used in this Safety Manual, a *qualified person* is defined as: a person who, by possession of a recognized degree of certificate of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work. Other qualified persons may include master mechanics and after-sales service technicians of the manufacturer. *See Also:* Certified Operator

Qualified Operator

Operators shall be considered qualified when they have completed a program of training and supervised operation of concrete pumps and have passed a practical operating examination of their ability to operate a specific model and type of equipment as well as their understanding of the controls and operating procedures. Furthermore, the operator must meet the knowl-

edge and physical requirement sections of the concrete pumping safety standard.

Qualified Personnel

A generic term used to describe a person who is qualified in the area of application. For example, having your boom repairs inspected by "qualified personnel" before use would refer to inspection by a certified welder or certified welding inspector. Having repairs to your hydraulic system done by "qualified personnel" would refer to repairs made by qualified workshop personnel.

Qualified Workshop Personnel

An individual who:

- has reached the age of 18 years,
- is physically and mentally capable,
- has been trained in proper repair, maintenance, and inspection procedures plus the pertinent safety rules for concrete pumps and related equipment,
- has demonstrated their capabilities to their company in regards to the above mentioned procedures and rules, and
- can be expected to perform these duties, as assigned, in a reliable manner.

Rock Jam

A specific type of blockage caused when the cement and fines of the concrete are not present in sufficient quantity to fully coat the larger aggregates and the walls of the delivery system. In these cases, the rock (larger aggregates of the mix) will form a wedge inside of the pipe. Resistance to movement then becomes overpowering and the concrete stops. *See Also:* Blockage.

Separate Pipeline

A pipeline that is laid between the concrete pump and the point of discharge, other than the placing boom pipeline.

Shutoff Valve

In hydraulics: a valve with the ability to stop the flow or pressure of hydraulic oil. It must be able to withstand the maximum pressure of the hydraulic circuit that it controls. In concrete: A manually or hydraulically operated valve that will prevent the flow of concrete in either direction. The shutoff valve must be able to withstand the maximum pressure on the concrete of which the pump is capable of exerting.

Soil Pressure

The force per square area that is exerted on the ground by the outrigger legs. The amount of pressure that the soil will support varies with the composition and compaction of the soil. To make a determination on the stability of the soil, see the chart on page 22 of this manual.

Sponge Ball

A medium to hard sponge formed into a sphere and used to clean the inside of delivery pipelines. *See Also:* Go Devil

Spotter

A spotter is a person who stands at a vantage point where he (she) can see both the point of discharge and the operator of the pump. The spotter would

then direct the operator to operate the unit as required by the job circumstances with two-way radios or hand signals. A spotter can be anyone who is familiar with the safety rules for the pump and workers and is equipped with a radio or knows the appropriate hand signals. A spotter is needed whenever the operator cannot safely see the point of placement or the distance between the unit and an unsafe area. *See Also:* Guide

Sucking Back

The act of putting the concrete pump into the reverse mode for any of several reasons.

Thrust Block

Also known as a "dead man". This is a large block of poured concrete, usually with one or more sweep elbows cast inside, placed at the bottom of a vertical run for the purpose of supporting the weight of the vertical run and for lateral stabilization of the pipeline. It stabilizes and supports the vertical run by virtue of its enormous mass (normally one cubic yard or larger).

Towing Vehicle

In this manual, *Towing Vehicle* applies only to vehicles that tow trailer mounted concrete pumps. It is the vehicle that you will use to tow the trailer on the road, on the job site, or in the yard. See the safety rules regarding this subject on page 10 of this Safety Manual.

Transport Position

This relates to the position of the boom when you will be driving the unit. The travel position of the boom is the position of the boom when it is completely folded and lowered into the rests.

Unauthorized

Without authority, without permission. Examples: Unauthorized operation of the boom could be operation by a passer-by, unauthorized repairs to the boom could be repairs designed without the manufacturer's knowledge.

Unintentional Movement

Movement of the pump, boom or related equipment without a specific intentional command by the operator. An example of an unintentional movement would be if an operator fell while walking with the remote control box and accidentally hit a joystick, causing a boom movement.

Vertical Run

Sections of concrete delivery pipeline that are running in an up (or down) direction. Vertical runs have very specific procedures and rules for installation, support, cleaning, and inspection. Concrete pumping personnel should, therefore, have specific training in these procedures and rules before attempting to use them in a job setting.

Water Jet

The actual stream of water that comes out of the end of a water hose or pressure washer. This is the only part of the water system that needs to go into the hopper, concrete valve, or water box for cleaning.

X. Recommended ACPA Hand Signals

The American Concrete Pumping Association (ACPA) recommends using the following hand signals as standard procedure. (Figure 53).

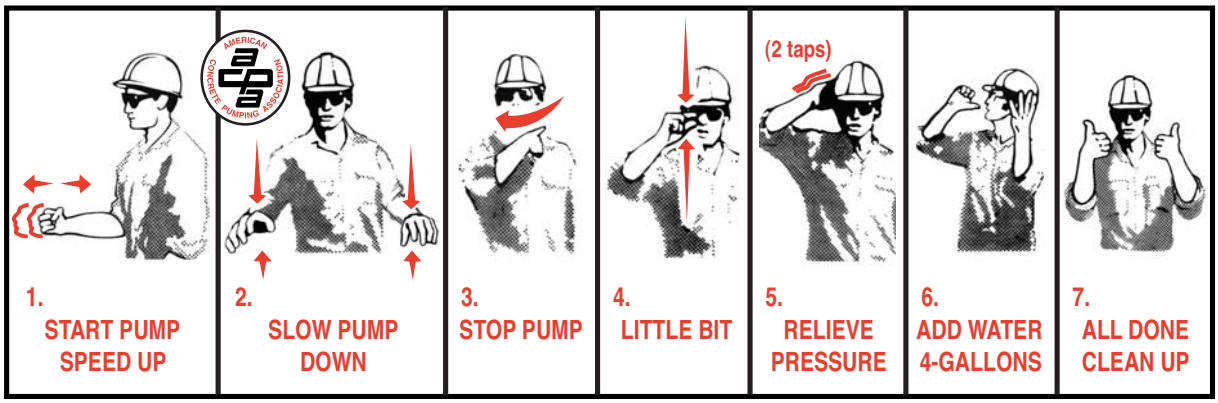


Figure 53
ACPA recommended hand signals for non-boom pumps

XI. Bibliography

Further information regarding concrete pumping is available from the sources listed below. Information for this book was gathered from several different sources, including the following books:

PUMPING CONCRETE AND CONCRETE PUMPS © F. W. Schwing, GmbH

CONCRETE PUMP OPERATOR'S GUIDE TO SAFETY © British Concrete Pumping Association

The MANUAL and ADVISORY SAFETY CODE of PRACTICE for CONCRETE PUMPING © British Concrete Pumping Association

SAFETY STANDARD FOR CONCRETE PUMPS, PLACING BOOMS, AND DELIVERY SYSTEM by the Concrete Pump Manufacturers Bureau

Additional technical information and/or graphic were supplied by:

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The American Concrete Pumping Association

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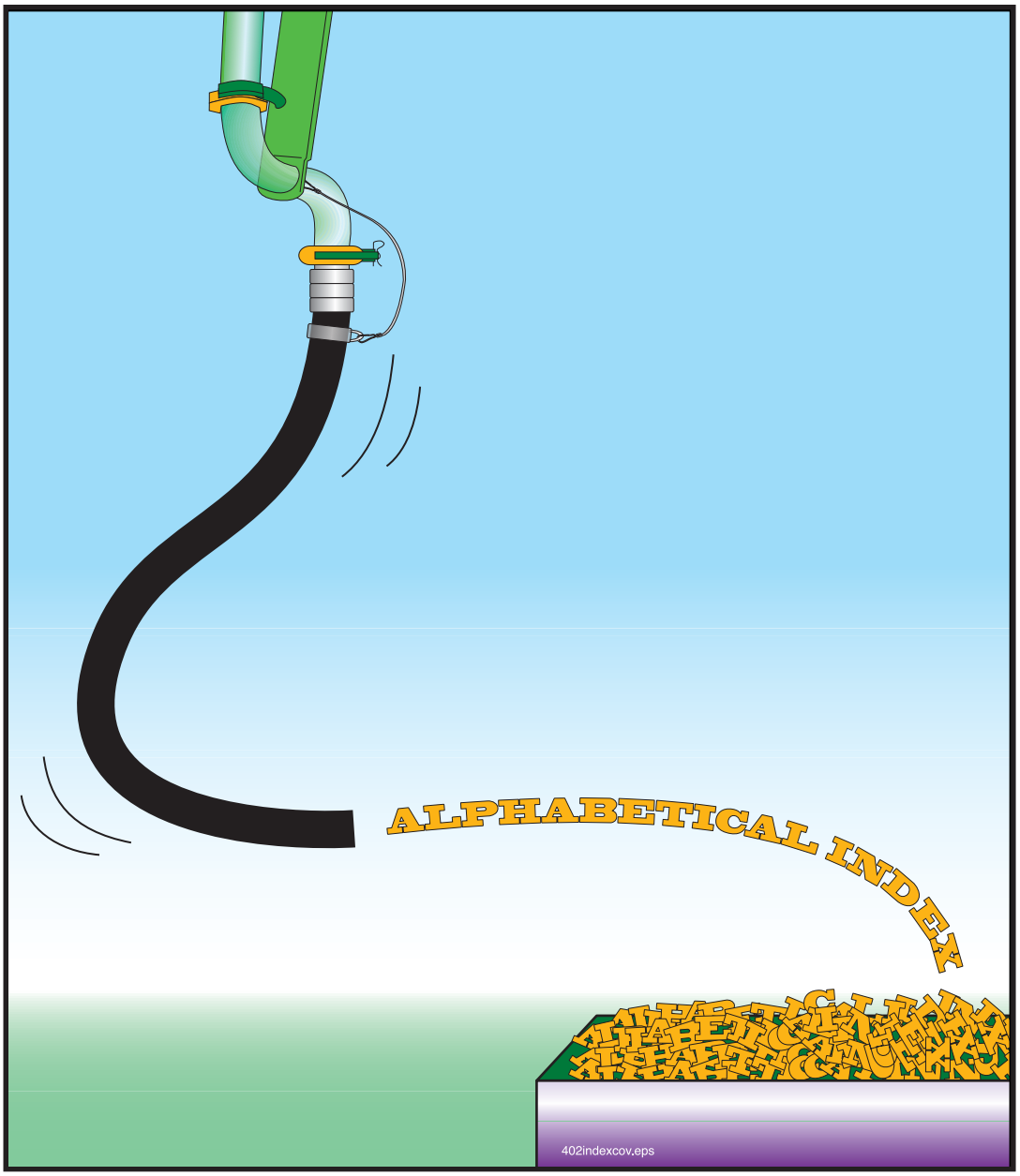
APPENDIX

SAFETY MANUAL



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SAFETY MANUAL

Information contained in this Safety Manual is not intended to supercede the manufacturer's recommendations or company policies.

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